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The Pebble Project Draft Compensatory Mitigation Plan (January 2020) provides no habitat replacement or preservation to offset thousands of acres of wetland and aquatic habitats that the Pebble Mine Project would destroy, degrade, or fragment

A Report Prepared for Earthworks

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Summary:

Despite being fully aware for more than a decade[2] of its responsibilities to offset unavoidable impacts to wetland and aquatic areas that would be lost or degraded as a result of its proposed mining of the Pebble deposit, the "final" compensatory mitigation plan submitted in January, 2020 by the Pebble Limited Partnership (PLP) proposes out-of-kind actions in locations far from the proposed mine project that would not offset the losses and degradation of thousands of acres of wetland and aquatic habitats that the Final Environmental Impact Statement (FEIS) states would result from the construction and operation of the Pebble Mine Project.

Instead, PLP proposes three categories of actions it believes are worthy of compensatory mitigation credits to offset its projected impacts:

1. To fund one-time improvements to three village sewage treatment plants or pipelines. The combined population of Newhalen, Nondalton, and Kokhanok is about 700 people, and the combined wastewater stream of these villages is approximately 1 percent of what the initial Pebble Mine Project would create and need to treat;

2. To fund one-time culvert improvements to improve anadromous fish passage where the Alaska Department of Fish and Game has reported fish passage problems. PLP would limit its culvert improvement work to whatever number of culverts it would need to improve or replace in order to provide better fish access to a total of 8.5 miles of streams, the closest of which is over 90 miles from the proposed Pebble Mine site; and

3. To remove marine debris on 7.4 miles of beach on Kamishak Bay in the vicinity of PLP's formerly proposed port site on Amakdedori Bay. Debris removal would continue periodically over the purported 20-year lifespan of the Pebble Mine Project.

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[1] Thomas G. Yocom formerly served as National Wetlands Expert for the U.S. Environmental Protection Agency before retiring in 2005. Since 2006, he has represented private sector and public agency clients on projects and agency actions involving Clean Water Act compliance pursuant to Section 404 of the Clean Water Act.

[2] Consultants to PLP (then NDM) were hired in 2004 to delineate wetland and aquatic areas, assess wetland functions and values, and to identify compensatory mitigation opportunities for a considerably larger Pebble Project (https://foiaonline.gov/foiaonline/api/request/downloadFile/EPA-9498-0000258-EPA-9498-0000296.pdf/2146f53e-4838-4b9e-97c0-b35fe6c7a408). Subsequently, the applicant began meeting with the Corps and other Federal and State agencies from 2007 to 2019 in pre-application meetings to discuss its project and the regulatory requirements that it would be facing (see: http://dnr.alaska.gov/mlw/mining/largemine/pebble/twg/index.cfm)

There are no accepted means of calculating the compensatory mitigation credit that could legitimately be applied to these three proposed categories of action, with the exception of the culvert improvement. However, the culvert improvement would not create any new stream habitat to replace any of the 100+ miles of streams that would be destroyed by the Pebble Mine Project; even if it did, the habitat improvement would be a tiny fraction of the direct and indirect project impacts.

Instead, PLP admits that it cannot find compensatory mitigation opportunities near the project site, nor in the immediately surrounding watersheds.[3] And, lacking any substantive compensatory mitigation measures, PLP and the Corps appear to be fashioning arguments to not only allow consideration of bizarre measures such as the aforementioned trash removal and treatment plant upgrades, but to bold-facedly claim that compensatory mitigation should not be required, reasoning that there is an overabundance of habitat in Alaska.

Author's Disclaimer:

The analyses herein accept the applicant's acreage figures and characterizations of wetland types. In assessing the adequacy of mitigation measures proposed, the analysis also presumes that there are no less environmentally damaging alternatives that are practicable to achieve the basic project purpose, either off-site or on-site, other than what is described in the FEIS as the applicant's preferred alternative.

However, there are serious unresolved questions about alternatives that should have been evaluated fully, but which the Corps dismissed inappropriately.[4] In addition, the Corps revised preliminary jurisdictional determination of the reach and extent of waters of the United States is flawed and continues to rely primarily upon data that are long out-of-date and/or that utilized methods that are ill-suited for determining federal Clean Water Act jurisdiction.[5] And, finally, the proposed project may not be financially viable,[6] and more likely is the first phase of a much larger mine, the impacts of which would dwarf those for which compensatory mitigation is discussed herein.

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[3] This more-or-less agrees with the conclusion this author reached in a refereed journal article in 2012. See: Yocom, Thomas G. and Rebecca L. Bernard. 2013. Mitigation of Impacts from Large-Scale Hardrock Mining in the Bristol Bay Watershed. Seattle Journal of Environmental Law, Volume 3, pages 71-100.

[4] Yocom, T.G. 2019. The Corps determination of basic and overall project purposes improperly eliminates consideration of less environmentally damaging practicable alternatives. Report prepared for Earthworks. May 5, 2019. 12 pages.; and Yocom, T.G. 2020. Review of Pebble FEIS, Appendix B: Alternatives Development Process - How the Alaska District of the Corps biased its analysis to favor the applicant. Report prepared for Earthworks. August 19, 2020. 12 pages.

[5] Yocom, T.G. 2018. Questioning the Corps' preliminary jurisdictional determination for POA-2017-271. Report prepared for Earthworks. June 17, 2018, 39 pages. Report previously submitted to the Corps, Alaska District; and Yocom. T.G. 2020. The Alaska District of the Corps of Engineers' Revised Preliminary Jurisdictional Determinations for POA-2017-271 Inappropriately Reduces Estimates of the Direct Impacts of the Pebble Mine Project to Wetland and Aquatic Areas by Over 1200 Acres. Report prepared for Earthworks. August 19, 2020. 9 pages.

[6] Borden, R.K. 2019. Pebble Mine Project Economics. Letter from Richard K. Borden to Shane McCoy, USACE, Alaska District. May 28, 2019. 7 pages.

Pebble Mine Project impacts thousands of acres of wetland and aquatic areas for which compensatory mitigation is required

According to the FEIS (Chapter 4, Table 4.22-40), proposed mining operations for the initial 20-year phase of the Pebble Mine Project would have direct and indirect permanent and temporary[7] adverse impacts to at least 4,614 acres of wetlands and 191 miles of streams. Proposed mining operations for the expansion project would have direct and indirect permanent and temporary adverse impacts to at least 15,198 acres of wetlands and 538 miles of streams.[8]

Pursuant to federal regulations, "*no discharge of dredged or fill material shall be permitted unless appropriate and practicable steps have been taken which will minimize potential adverse impacts of the discharge on the aquatic ecosystem.*"[9] The regulations go on to state that where discharges would adversely affect plant and animal populations permittees should use "*planning and construction practices to institute habitat development and restoration to produce a new or modified environmental state of* <u>*higher ecological value*</u> *by displacement of some or all of the existing environmental characteristics.*"[10] (emphasis added)

Accordingly, even if one were to accept the Corps' flawed determination of the reach and extent of the "waters of the United States," including wetlands that would be permanently destroyed by the 20-year initial phase of the Pebble Mine Project, the project sponsor, the Pebble Limited Partnership (PLP), should have an enormous regulatory burden to offset thousands of acres of wetland and aquatic habitats.

Background

The author reviewed PLP's previous Draft Compensatory Mitigation Plan (CMP) that was included in the Draft Environmental Impact Statement (DEIS) for the Pebble Mine Project.[11] Some of the text within this updated report is duplicative of that earlier report, insofar as the past statements and assurances made by the applicant are concerned, as well as the underlying requirements for compensatory mitigation under the Clean Water Act regulations pursuant to Section 404.

As the author wrote in reviewing the CMP in the DEIS, the applicant has long acknowledged compensatory mitigation as "*one of the most basic requirements of the permitting process: full, functional mitigation for all unavoidable, residual project impacts*," stating further that "*PLP has*

[7] The FEIS (4.22-5) defines temporary impacts on the basis of duration. In the FEIS, impacts are classified as temporary or short-term when wetland or aquatic functions would be reduced during the construction phase only, with pre-construction function returning after construction ends. The total construction phase is expected to last for 4 years, but individual temporary impacts are likely to last for only one or two growing seasons. Several impacts classified as temporary in the FEIS are longer term and are more properly classified as permanent.
[8] Schweisberg, Matthew. 2019. Pebble Mine Final Environmental Impact Statement (FEIS): Anticipated Adverse Impacts to Wetlands. A Report for the Wild Salmon Center. August 10, 2020. 20 pages.
[9] 40 CFR 230.10(d)
[10] 40 CFR 230.75(d)
[11] See: Yocom, Thomas G. 2019. The Pebble Project DEIS provides no substantive proposals of compensatory mitigation for losses of wetlands and aquatic areas. A report prepared for Earthworks. June 6, 2019. 16 pages.

consistently acknowledged its mitigation responsibility and has assumed that permit requirements would stipulate mitigation obligations amounting to a significant multiple of actual impacts, resulting in a net gain in anadromous and resident fish productive capacity" (emphasis added).[12] Furthermore, PLP stated years ago that it had "*identified numerous opportunities for increasing anadromous fish habitat, as well as the productive capacity of that habitat for anadromous fish, greatly in excess of reasonably anticipated losses.*"[13] (emphasis added). It is noteworthy that these statements were made in relation to much larger proposals to mine the Pebble deposit, including 25-, 45-, and 78-year mines.

In acknowledging the requirements of the federal mitigation rule, PLP has stated that it understands that compensatory mitigation will be required for "unavoidable" impacts. And, in applying for a permit, PLP understands that it must clearly demonstrate that any proposed discharges of dredged or fill material into wetlands or other special aquatic sites are unavoidable in order to achieve the basic purpose of its proposal, in this case mining. In fact, beginning with field studies beginning in 2004 and pre-application meeting with the Corps and other federal and state agencies that began in 2007, PLP (Northern Dynasty Minerals) was fully aware of its needs to develop a comprehensive compensatory mitigation plan.

The senior author of a well-documented review found that compensatory mitigation was generally not successful unless mitigation ratios were higher than 1:1 and closer to 2:1 (*i.e.*, a greater acreage or length of stream miles restored than were lost as a result of a project).[14] That author later became an official of PLP's parent corporation, Hunter Dickenson, and has maintained the view that in order to ensure that compensatory mitigation will adequately offset the losses of acreage and function, mitigation ratios should be greater than 1:1 and closer to 2:1.[15]

However, rather than propose a comprehensive compensatory mitigation plan in its 2018 Permit application, based on its own studies and assurances to implement the measures it had previously

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[12] July 23, 2012 letter from Thomas C. Collier, Esq., Steptoe & Johnson, LLC (before Mr. Collier became CEO of PLP), to Office of Environmental Information Docket, Docket Number # EPA-HQ-ORD-2012-0276. Collier specifically identifies measures such as "*judicious water management, including storage, and strategic delivery of excess water to streams and aquifers without adverse impacts such as seasonally incompatible temperatures; providing access to existing but inaccessible aquatic habitats and creation of extensive new habitats such as groundwater-fed secondary channels for anadromous and resident fish spawning, rearing and overwintering in local floodplains; concentrating mitigation efforts in more heavily utilized lower portions of local watersheds (North Fork Koktuli, South Fork Koktuli, Upper Talarik Creek) in order to maximize actual use of new habitat by the fish for which it is intended. Offsite but in-watershed (Kvichak/Nushagak) opportunities include such things as fish passage at significant anadromous fish barriers, opening up very large areas to anadromous access, significantly increasing salmon runs in associated systems. More remote opportunities include facilitation of reclamation and rehabilitation activities in existing disturbed areas.*" None of these measures are proposed in PLP's permit application.

[13] Letter from Richard E. Schwartz (Crowell & Moring, LLC, Washington, DC on behalf of PLP) to Arthur A. Elkins, EPA Inspector General, January 9, 2014. 26 pages.

[14] See Quigley, J.T., and D.J. Harper. 2006. Effectiveness of fish habitat compensation in Canada in achieving no net loss. Environmental Management 37: 351-366.

[15] "*...our research demonstrated that many compensation projects that were deemed failures would have been successful had they simply employed larger compensation ratios..... Ultimately, regulators should require more than 1:1 replacement for aquatic habitat displaced by development activity - perhaps as high as 2:1.*" Jason Quigley, Hunter Dickenson Inc. April 28, 2014 letter to EPA Region 10, Dennis J. McLerran, Regional Administrator.

stated were available, PLP's permit application simply stated that "*mitigation will be considered in detail throughout the permitting and NEPA processes*"[16] (emphasis added). And, the applicant stated further that "*PLP will work with the USACE (Corps) throughout the process to identify and implement a compensatory mitigation plan that is appropriate for the final Project*"[17] (emphases added).

PLP's January 2020 Draft CMP acknowledges the types of mitigation measures called for in the 2008 federal mitigation rule and evaluates opportunities to utilize such measures to offset impacts of the Pebble Project, including mitigation banks and in-lieu fee providers. PLP concludes that there are no mitigation banks or in-lieu fee providers that could provide any compensatory mitigation for the project as proposed, concluding further that permittee-sponsored mitigation is its only available choice. This author reached similar conclusions in a law review article published 7 years ago, when PLP was touting its ability to replace and improve aquatic habitat.[18]

With the July 2020 release of the Final Environmental Impact Statement for the Pebble Project, PLP is really no closer to actually offsetting any project impacts to wetland and aquatic areas than it was when it had no specifics to offer.

Compensatory Mitigation Measures Proposed in the FEIS

After having had well over a decade to develop a proposal to offset what PLP has known will be massive losses of wetland and aquatic areas, PLP offers no actual offsets in terms of the reach and extent of the nation's waters. No wetland acreage whatsoever will be created, restored, or preserved through PLP's proposed mitigation measures. No stream miles will be replaced or preserved. No open-water bodies, including vegetated shallows, will be offset. In other words, the net losses of the "waters of the United States," including wetlands, will be 100%, not including secondary impacts to additional wetland and aquatic areas that will occur downstream of the project.

What PLP proposes is to essentially transfer its "permittee" responsibility to offset its project impacts by, instead, proposing to fund actions to be taken by third parties. PLP also seeks compensatory mitigation credit for its destruction of wetland and aquatic areas by proposing to clean up trash and debris over a 20-year period on a Cook Inlet beach roughly 60 miles from the proposed Pebble Mine site. Worse, PLP offers to "fix" purported water quality and fish passage problems that are miniscule compared to the very same kinds of environmental problems the construction and operation of the Pebble Mine Project would create on a massive scale.

1. Funding third-party wastewater treatment facility upgrades

First, PLP proposes to fund, on a one-time basis, improvements to the wastewater treatment facilities in the villages of Newhalen, Nondalton, and Kokhanok, whose combined population is

[16] Pebble Project Department of the Army Application for Permit (POA-2017-271), December 2017, page 31.
[17] Pebble Project Department of the Army Application for Permit (POA-2017-271), December 2017, page 32.
[18] Yocom, Thomas G. and Rebecca L. Bernard. 2013. Mitigation of Impacts from Large-Scale Hardrock Mining in the Bristol Bay Watershed. Seattle Journal of Environmental Law, Volume 3, pages 71-100.

about 700 people. The combined wastewater stream of these villages is approximately 1 percent of what the initial Pebble Mine Project would create and need to treat and release. And PLP provides no water quality monitoring information from the receiving waters at these treatment facilities that demonstrate that the wastewater discharges from any of these villages are causing significant water quality violations. And, even if there were significant pollution problems, logically it should be the responsibility of these villages, and not PLP, to correct them.

But, even if one accepts that PLP's funding of these proposed improvements is a legitimate form of compensatory mitigation for permanent losses of wetland and aquatic areas (it is not), the only possible aspect of the Pebble Mine Project that it might appropriately offset would be the impacts of the mine's own wastewater discharges.[19] Simply funding third-party wastewater treatment upgrades does nothing to offset the thousands of acres of wetlands, streams, and open-water bodies that the Project would permanently destroy.

Moreover, PLP admits that it has no authority to operate or maintain the wastewater treatment facilities for which it proposes to fund upgrades. The actual operation and maintenance of these treatment works will remain the responsibility of the associated villages. PLP proposes no long-term commitment to fund future upgrades, nor any long-term maintenance concomitant with its own burden to offset massive permanent losses of wetland and aquatic acreage and functions. PLP's proposal to fund village wastewater upgrades is without merit as compensatory mitigation.

2. Funding third-party culvert improvements to improve migratory fish passage

PLP proposes "*to restore Pacific salmon habitat as compensatory mitigation for the unavoidable losses to aquatic resources that would result from the Pebble Project's discharges to waters of the U.S., including wetlands (WOUS). The goal of this PRM plan is to rehabilitate* <u>*8.5 miles*</u> *of Pacific salmon habitat by removing or replacing culverts that limit the passage of juvenile and/or adult Pacific salmon.*"[20] (emphasis added). In stark contrast, the Pebble Mine project would permanently destroy least 4,614 acres of wetlands and 191 miles of streams in its initial 20-year phase,[21] and likely adversely affect many more miles of downstream habitat.

PLP again proposes to hand off its mitigation responsibilities to third parties by "*proposing to implement this PRM* (Permittee Responsible Mitigation) *through* <u>*ad hoc payments to private individuals, and non-governmental or governmental organizations (partners) that would perform the culvert replacement activity that would provide the compensatory mitigation for PLP.*</u>"[22] PLP

[19] <u>Author's note</u>: If PLP is truly interested in improving off-site wastewater to offset its mining impacts, it should have considered committing to the long-term cleaning up and treatment of mining wastes from abandoned mines in Alaska that have no viable financially responsible party, rather than municipal waste at small villages. But this would still do nothing to offset the massive losses of wetland and aquatic areas that the Pebble Mine Project would destroy.

[20] See: Pebble Project Permittee-Responsible Mitigation Plan for the Removal of Pacific Salmon Passage Barriers, page 4, in Pebble FEIS, Appendix M – Mitigation (page 234 of 438).

[21] Schweisberg, Matthew. 2019. Pebble Mine Final Environmental Impact Statement (FEIS): Anticipated Adverse Impacts to Wetlands. A Report for the Wild Salmon Center. August 10, 2020. 20 pages.

[22] See: Pebble Project Permittee-Responsible Mitigation Plan for the Removal of Pacific Salmon Passage Barriers, page 4, in Pebble FEIS, Appendix M – Mitigation (page 234 of 438).

proposes this on a one-time basis with the caveat that it would monitor the culverts it pays to upgrade on an annual basis for no more than 5 years post-construction.

In arguing that simple culvert upgrades should compensate for thousands of acres of habitat losses, PLP dismisses its immense proposed impacts through claims that the habitats it will destroy are not rare (*i.e.*, expendable), but nevertheless states its willingness to do a little something to help the offset some of the documented[23] salmon habitat it will eliminate:

> "*The removal of fish passage barriers meets the goals of PLP's Compensatory Mitigation Plan. The proposed Pebble Project wetland impacts will occur in remote watersheds with large expanses of relatively undisturbed wetlands, and the remaining wetlands are at low risk of being cumulatively degraded. The impacted wetlands in the affected watersheds are not rare or unique; however, construction would place fill in Pacific salmon streams and adjacent wetlands, which are an important resource to the economies and subsistence activities of local communities. PLP's proposed discharge of fill material will result in the removal of 8.5 miles of Pacific salmon habitat within the headwater streams of the Koktuli River, a tributary to the Nushagak River.*" (PLP January 2020 Draft Compensatory Mitigation Plan, page 4, emphasis added).

As with its proposal to fix third-party wastewater treatment facilities while creating a gigantic new waste stream of its own, PLP is proposing to improve a few under-performing culverts as compensatory mitigation when its Pebble Mine Project could require construction of hundreds of new culverts on previously un-culverted streams, many of which have been inadequately surveyed for fish and other aquatic life.[24] PLP's proposal presumes that the only species worthy of concern are Pacific salmon, whereas the Corps of Engineers own national guidance for culverts requires consideration of all aquatic species.[25] Furthermore a majority of culverts proposed in the FEIS are not specified at this time to facilitate fish passage, [26] and none are

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[23] Many of the streams in remote areas of Alaska have not been studied for the presence or absence of life stages of salmonids, including within the Pebble Mine Project footprint. The Corps and PLP simply do not know the full extent of habitat for salmonids and other aquatic species.

[24] The actual number of culverts that PLP will need to construct is not known but is to be worked out later, during construction. Here are excerpts from the Final EIS: a) *"The exact number and design of waterbody crossings would be determined during final design and permitting."* Final EIS, page 4.13-8, page 4.16-31; b) *"Under Alternative 3, 205 waterbody crossings would be required, including 17 bridges. The remaining crossing structures would consist of various sizes and designs of culverts, depending on fish passage requirements."* Final EIS, page 4.13-19; and c) *"Under Alternative 3, waterbody crossings would include 17 bridges and 112 culverts* (see Chapter 2, Alternatives)." Final EIS, page 4.16-53.

[25] "*Aquatic Life Movements. No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. All permanent and temporary crossings of waterbodies shall be suitably culverted, bridged, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species. If a bottomless culvert cannot be used, then the crossing should be designed and constructed to minimize adverse effects to aquatic life movements.*" (See: C. Nationwide Permit General Conditions, 2. Aquatic Life Movements. In: Federal Register/Vol. 82, No. 4/Friday, January 6, 2017/Rules and Regulations, page 1998).

[26] The actual number of culverts that would be needed for the Pebble Mine project appears to be unknown, and there are serious questions whether the streams that would require culverts or other road-crossing structures have been sufficiently surveyed to determine if fish passage is required.

proposed as bottomless culverts, as is also recommended by the Corps for culverts installed as part of its Nationwide General Permit program (see footnote 25, above).

None of the culverts that PLP proposes to improve are anywhere close to the mine; the closest appears to be over 90 miles from the proposed Pebble Mine site. And no specific culverts are actually proposed at this time for reviewers to evaluate.[27] More importantly, the actions proposed by PLP do not offset any permanent losses of wetland and aquatic habitats that the Pebble Mine Project would destroy.

No new habitat is being created. Rather salmonid access would be improved to stream habitat that already exists and which is already performing ecological functions and supporting other aquatic life. The net loss of "waters of the United States," including wetlands would remain 100% after implementation of PLP's proposed culvert upgrades.

And, finally, the issue looms large as to who the responsible party is for existing culverts that are under-performing.[28] As with the wastewater treatment facilities for which PLP proposes to fund one-time upgrades, existing permitted facilities and structures are not PLP's responsibility to rehabilitate. It is the owners/permittees that bear that responsibility, and PLP should not be given credit for cleaning up someone else's mess in exchange for destroying massive areas of pristine habitat.

3. Removing marine debris on a remote beach on Cook Inlet.

PLP proposes "*removal of marine debris at Kamishak Bay, as compensatory mitigation for the unavoidable losses to aquatics resources that would result from the Pebble Project's proposed discharges of dredge or fill material into waters of the U.S., including wetlands (WOUS). The primary purpose of this PRM project is habitat restoration, although it also provides protection to wildlife, including threatened and endangered species, by removing potential entanglement or ingestion hazards.*"[29]

As a compensatory mitigation measure, this is ridiculous. This proposal offsets nothing in terms of the massive losses of wetland and aquatic habitats that would result from the first phase of the Pebble Mine Project. And PLP provides no evidence whatsoever that trash and debris on this remote beach has caused any measurable entanglement or ingestion problems to the fish and wildlife that PLP purports would benefit from its trash removal efforts. And like its other compensatory mitigation proposals, PLP seeks wetland habitat compensation credit for picking

[27] "*The selection of specific culvert replacement projects would occur after receipt of the approved Department of the Army (DA) Permit for the Pebble Project, in coordination with the Alaska Department of Fish and Game (ADF&G), interested land or Right-of-Way (ROW) owners, and partners.*" (See PLP January 2020 Draft Compensatory Mitigation Plan, page 4 in the Pebble FEIS Appendix M – Mitigation).

[28] In its September 2019 comments submitted to PLP on its draft Compensatory Mitigation Plan, the Corps cautioned that "*Credits can only be given if the culvert upgrades are not a result of non-compliance of an authorization. If the culvert was authorized, it is the responsibly of the permittee to comply with the maintenance of the feature.*" (Memo titled: PLP CMP USACE comments.pdf, from Shane McCoy, Program Manager, to James Fueg and Tim Havey, PLP Representatives. September 03, 2019, 10 pages).

[29] See: Pebble Project Permittee-Responsible Mitigation Plan for Marine Debris Removal at Kamishak Bay, page 1, in Pebble FEIS, Appendix M – Mitigation (page 256 of 438).

up trash and debris off-site, when at the same time it is seeking mitigation credit for avoidance and minimization by committing to remove its own project's trash and debris.[30]

Even PLP's best efforts to depict the issue in photographs suggest that PLP is proposing to fix a problem that doesn't exist. Where one might expect to see images of a beach with heaping mounds of debris and potential sources of chemical pollution, the reader is presented with photographs of a plastic bucket, minor bits of floating debris, and a close-up of a net float (Figure 1), although PLP reports observing a "*variety of materials (e.g., plastic, metal, polystyrene foam), insulation materials (e.g., polystyrene foam sheets and fragments), barrels, buckets, plastic bottles, propane canisters, fish nets and seines, rope, pallets, lumber, coolers, fish totes, pressurized cannisters for paint and lubricant, tarps and fabric.*"[31]

It is also clear that PLP did not do an extensive survey of Alaskan beaches where it could maximize the credit it might receive from beach clean-up. Rather, the proposed debris removal plan is PLP's meager effort to claim some on-site mitigation associated with its previously proposed port in Amakdedori Bay; plus, PLP would already have had Pebble Project staff nearby, making it easy to go out periodically and pick up trash during the alleged 20-year life of the project, as is proposed by PLP.

Picking up debris on an 8.5-mile stretch of remote beach -- debris for which no measurable environmental harm has been documented – deserves zero credit for offsetting permanent losses of thousands of acres of pristine wetland and aquatic habitats. Even if there was an accepted means of converting trash removal to the ecological value of pristine wetlands and streams, it is inconceivable that the habitat value equivalent of trash removal would equate even to a few acres, and then only if the habitat to be lost was highly degraded.

The Corps should have rejected this proposal out-of-hand. Instead, by including it in the FEIS, the Corps appears intent on bypassing the letter and spirit of the regulations in order to issue a permit for a project that, as proposed, cannot possibly comply with the Clean Water Act regulations that the Corps is responsible to enforce.

Other potential mitigation measures described in the FEIS but not included in PLP's January 2020 Compensatory Mitigation Plan

The FEIS suggests that the Corps and PLP may be considering additional mitigation measures that appeared as suggested Expert Agency Comments in the Preliminary FEIS and were carried forward into the FEIS.[32] As described in Table M-1, it was suggested that the applicant evaluate inactive mines to see if there are orphan mine sites with no viable financially responsible party,

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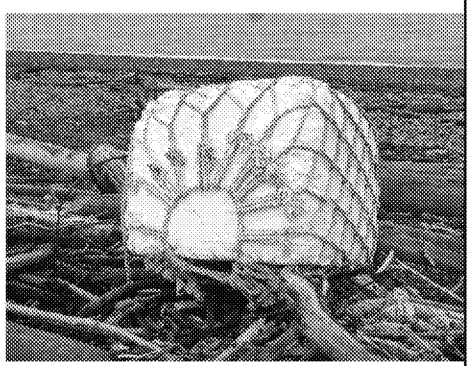
[30] As one element of its proposed restoration plan to help "*ensure that habitat loss associated with construction activities is temporary and that impacted areas are appropriately restored to their pre-construction conditions,*" PLP proposes to "*Clean up trash or other construction debris (e.g., flagging, survey lath, plastics).*" See Table 5-2: Applicant's Proposed Avoidance and Minimization Incorporated into the Project, Pebble Project FEIS page 5-7.
[31] See: Pebble Project Permittee-Responsible Mitigation Plan for Marine Debris Removal at Kamishak Bay, pages 4-5, in Pebble FEIS, Appendix M – Mitigation (page 259-260 of 438).
[32] See: Table M-1: Assessment of Mitigation and Monitoring Measures Identified During the EIS Process. FEIS, Appendix M, page M-3.

Figure 1. Photos of a beach on Kamishak Beach included in PLP's January 2020 Compensatory Mitigation Plan for Marine Debris Removal

Figure 2. Amakdedori Beach (view south)

Figure 3. Marine debris at Amakdedori Beach (view north)

Figure 4. Polystyrene foam buoy and ropes at Amakdedori Beach



Source: Pebble Project Permittee-Responsible Mitigation Plan for Marine Debris Removal at Kamishak Bay, pages 4-5, in Pebble FEIS, Appendix M – Mitigation (page 259-260 of 438).

and determine if such mine sites could provide compensatory mitigation opportunities for wetlands and other waters/special aquatic sites.

The FEIS lists possible hard rock and placer sites in the immediate watersheds surrounding the Pebble Mine Project including Shot, Synneva (Scynneva) Creek, and Bonanza Creek on State land sites, and Red Top, Unnamed (near tributary to Arcana Creek), and Monk's Hood on Federal lands.

No additional information is provided in the FEIS, other than the assessments that such sites may potentially be effective, could be subject to Corps jurisdiction, and might be "reasonable," though further investigation would be necessary. Table M-1 concludes that the likelihood of implementation of such measures is "possible," but no information is included as types and acreage of any wetland and aquatic areas, if any, at these sites, or actions that would need to be taken in order to offset unavoidable losses of wetland and aquatic areas at the Pebble Mine Project.

Conclusion

PLP's January 2020 Compensatory Mitigation Plan is based primarily on directing funds to third parties to finance temporary facility upgrades that have little or nothing to do with the quantity and quality of wetlands, streams, and open water bodies that the Pebble Mine Project would permanently destroy, or the important ecological functions that those habitats are providing and have provided for thousands of years.

Whereas the regulations call for those projects affecting plant and animal populations to achieve post-project ecological conditions that are higher than pre-project, PLP's plan, as proposed, results in a 100% net loss of wetland and aquatic acreage and functions.

Perhaps of even greater concern, there is little reason to expect that the applicant's project is a single-and-complete project as proposed. It is far too small to practicably exploit the mineral resources of the Pebble deposit or justify the extensive infrastructure that will be required, including a port, a pipeline across Cook Inlet, and an 80+ mile access road. And there is even less reason to accept PLP's claim that it would fill the mine pit with pyritic tailings and close it after 20 years of active mining, leaving the vast majority of the ore – ore that it has spent years delineating – unmined. There is no mining operation in history that has simply shut down and walked away for no good reason after only exploiting less than 10% of a known deposit,[33] particularly a deposit it has spent hundreds of millions of dollars over nearly two decades to delineate, develop, and lobby for.

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[33] According to PLP's June 2020 Project Description, the 20-year mine would extract 9% of the copper, 11.4% of the gold, and 7.1 percent of the molybdenum in the Pebble Deposit. The amount of copper that would be extracted dwarfs the quantities of copper and molybdenum that would be extracted. See page 13 of the revised project description.

Instead, it is far more than "reasonably foreseeable" that larger additional phases of development are inevitable,[34] and are, in fact, contemplated by the applicant.[35] As such, the realistically anticipated project impacts (12,445 additional acres of impacts to wetland and aquatic areas, according to the DEIS[36]) would dwarf those described in the FEIS, and the compensatory mitigation that should be required under the regulations would be extraordinarily large.

Even if the size of the proposed project and its planned closure were legitimate, a failure by the Corps to require that the applicant fully offset its 20-year proposed project impacts would result in unprecedented net losses of wetland and aquatic habitats beyond those of any copper mine ever proposed in the United States.[37] And obviously, these net losses would be several times more severe should this mine expand in the future.

As presently proposed, the author believes that the project fails to comply with CWA regulations with regard to compensatory mitigation [40 CFR 230.10(d)], and the lack of appropriate mitigation measures should lead to a determination that the project would cause or contribute to significant degradation of the aquatic ecosystem [40 CFR 230.10(c)]. Accordingly, the Corps should formally find that the Pebble Mine Project fails to comply with the 404(b)(1) Guidelines and is not permittable under these regulations. and thereby fail to comply with the regulations at 40 CFR 230.10(c), as well.

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[34] Borden, R.K. 2019. Pebble Mine Project Economics. Letter from Richard K. Borden to Shane McCoy, USACE, Alaska District. May 28, 2019. 7 pages.

[35] Northern Dynasty Mines President Ron Thiessen's presentation on Jan 22, 2018 at the Vancouver Resource Investment Conference: "*Well, I don't know too many mines that start off at a scale and don't change over time. I mean, one of the things is, you know, today I can't stand up here and tell you after 20 years what will be the <u>next mining method</u>. Will it be open pit, will it be <u>underground</u>, will we want to expand the concentrator, will we want to put a gold circuit in. So, why would we attempt to permit something like that today when we couldn't answer the questions that the Army Corps of Engineers would be asking us about that. If we want to do those things, then we will have to permit those as and when we decide how we're going to go about it. So, it's only natural we permit what we see in the foreseeable future as an operation. At 160,000 tons a day, <u>the resource that we have actually could last for 200 years</u>.*" (emphases added. See: https://www.youtube.com/watch?v=pBs1dnP_9eo)

[36] In comparing the estimated 3560-acres of direct wetland impacts of the applicant's 20-year proposal to those of an expanded 78-year mine, the DEIS states that "*the expanded footprint would increase the acres of wetlands and waters impacted by an estimated 12,445 acres*" (DEIS, Executive Summary, page 65). The 3560-acre figure does not include the additional 2345 acres of indirect impacts nor 510 acres of "temporary" impacts reported in the DEIS for the applicant's preferred alternative (DEIS, Executive Summary pages 60 and 65); this is a total of 10 square miles of wetland and aquatic habitats. If the indirect and temporary impacts are proportional to what would result from the 78-year mine expansion, the additional impacts to waters could be well over 20,000 acres (35 square miles). <u>Author's note</u>: The author has chosen to include herein the acreage figures from the DEIS. Although the author believes the DEIS figures are underestimates, the Corps' acceptance of PLP's revised estimates for the FEIS reduced the perceived project impacts to wetlands by over 2 square miles. The author believes the FEIS severely underestimates impacts, even though they remain immense.

[37] The author takes issue with the Corps' acceptance of PLP's delineation of the reach and extent of regulated wetland and aquatic areas at the project site. The author believes the estimates of direct and indirect impacts to wetland and aquatic habitats that are disclosed in the DEIS and in the FEIS are underestimates. Yocom, T.G. 2018. Questioning the Corps' preliminary jurisdictional determination for POA-2017-271. Report prepared for Earthworks. June 17, 2018, 39 pages. Report previously submitted to the Corps, Alaska District; and Yocom. T.G. 2020. The Alaska District of the Corps of Engineers' Revised Preliminary Jurisdictional Determinations for POA-2017-271 Inappropriately Reduces Estimates of the Direct Impacts of the Pebble Mine Project to Wetland and Aquatic Areas by Over 1200 Acres. Report prepared for Earthworks. (August 19, 2020).

Whereas PLP has, yet again, put forward a woefully inadequate compensatory mitigation proposal, the real problem here lies with the Alaska District of the Army Corps of Engineers. The Corps has done nothing to date to compel PLP to provide any meaningful offsets to what is likely the single most environmentally damaging proposal ever considered under the 404(b)(1) Guidelines. The Corps should long ago have rejected PLP's compensatory mitigation plans. In the author's view, the Corps has shown blatant disregard for compliance with Clean Water Act regulatory compliance and the national goal of no net loss of wetland and aquatic areas.

The Alaska District of the Corps of Engineers' Revised Preliminary Jurisdictional Determinations for POA-2017-271 Inappropriately Reduces Estimates of the Direct Impacts of the Pebble Mine Project to Wetland and Aquatic Areas by Over 1200 Acres

A report prepared for Earthworks

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Summary

In October 2019, the Pebble Limited Partnership (PLP), applicant for the Pebble Mine Project, submitted revisions to its wetlands maps that were included in the February 2019 Draft Environmental Impact Statement (DEIS), claiming that its earlier estimates were far too large. Its revised maps claim that the Pebble Mine Project, as proposed, would destroy roughly 2 square miles less wetland and aquatic habitats than had been disclosed to the public in the DEIS, even though its project footprint had grown.

The U.S. Army Corps of Engineers, Alaska District (Corps) quickly adopted these revised estimates in December 2019 with no apparent independent field verification of any wetland/upland boundaries. These revisions are questionable for several reasons, and even if they could be confirmed in the field, these revised estimates should have been disclosed in a revised DEIS and not the Final EIS (FEIS). The Corps also adopted PLP's wetland and aquatic areas maps for the northern transportation corridor (Alternative 3), that became the applicant's preferred alternative prior to release of the FEIS. Those maps are also suspect, as they rely almost entirely on observations made between 2004 and 2008, yet somehow find about half as much of the corridor is wetlands than was estimated in 2011 on the basis of those same data. It is also disturbing that many sections of the newest mapping effort on the road alignment have no updated field sampling and, in several cases, are mapped with no field sampling whatsoever.

Analysis

The wholesale changes to PLP's January 2018 Preliminary Jurisdictional Determination[2] (hereinafter PJD#1) for the mine site area, described and mapped in Revision 3[3] (hereinafter PJD#3) are based primarily on field work that PLP conducted during the summer of 2018. The DEIS was released months later in February 2019, yet these data were neither presented nor

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[2] Pebble Project Preliminary Jurisdictional Determination Report (Revision 1). Prepared for U.S. Army Corps of Engineers – Alaska District, Regulatory Division. Prepared by HDR. January 2018.
[3] Revised Report Pebble Project Preliminary Jurisdictional Determination Report. Revision 3. Prepared for U.S. Army Corps of Engineers – Alaska District, Regulatory Division. Prepared by HDR. November 2019.

acknowledged in that document, despite how seriously outdated the data were upon which the PJD#1 maps relied.

Whether the applicant withheld this new information, or whether the Corps simply chose to hurry the release of the DEIS without it is unknown. Nevertheless, the questionable reduction in the reach and extent of the "waters of the United States," including wetlands between the DEIS and FEIS wetlands is enormous (Figure 1). The new estimates of direct and indirect impacts to wetland and aquatic areas (based upon PJD#3 mapping) still amount to thousands of acres, but the Corps' rush to include them in a Final EIS, rather than a revised DEIS, creates a false impression that the Pebble Mine Project has somehow been modified to significantly reduce its impacts, when, in fact, the mine footprint and impacts have grown. Procedurally, the public will be given no opportunity under the National Environmental Policy Act (NEPA) for any substantive review of these changes or their questionable underpinnings.

Furthermore, the applicant's revised permit application and project description in June 2020 necessitated preparation of another revised PJD to cover EIS Alternatives 2 and 3 which utilize a northern transportation corridor around Iliamna Lake. That revised PJD (PJD#2and3)[4] is also suspect, relying almost entirely on data collected well over a decade ago, and also relying on aerial photointerpretation criteria for the proposed mine site that is for the most part, many miles away in different drainages with different underlying substrates.

The wetland and aquatic areas that were determined to be jurisdictional in PJD#1 and the DEIS were already questionable for several reasons.[5] The field data were far too old to be acceptable under the Corps' own policies, the methodologies for collecting and interpreting the field data had changed substantially, and some of the conclusions that areas were not wetlands were simply wrong.

Instead of requiring the applicant to start over, as would have been consistent with Corps national policies, the Alaska District accepted the applicant's PJD#1 maps, and formally signed off on them as the Corps' determination[6] of the reach and extent of the "waters of the United States" -- albeit under the Corps' policy for "preliminary jurisdictional determinations."[7] The applicant provided a description of how it had used remote sensing and aerial photography to extrapolate its on-the-ground field data to estimate the presence of wetlands in the many different

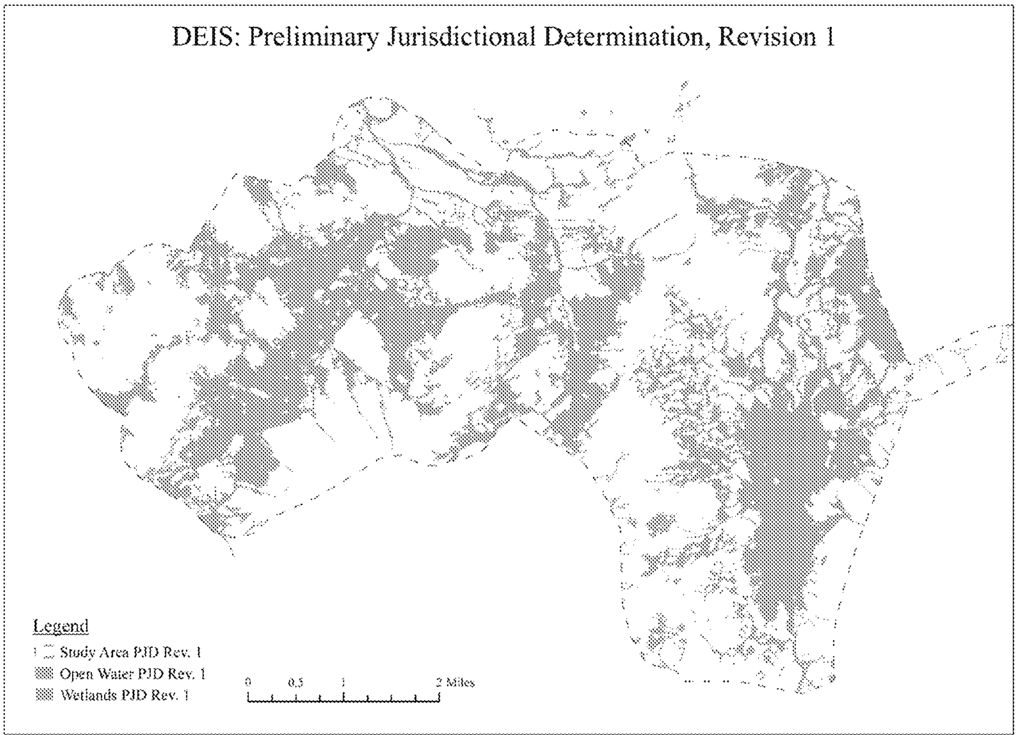
[4] Pebble Project Wetland Mapping Report. Project Alternatives 2 and 3. Prepared for Pebble Limited Partnership, LLC. Prepared by HDR. November 2019.

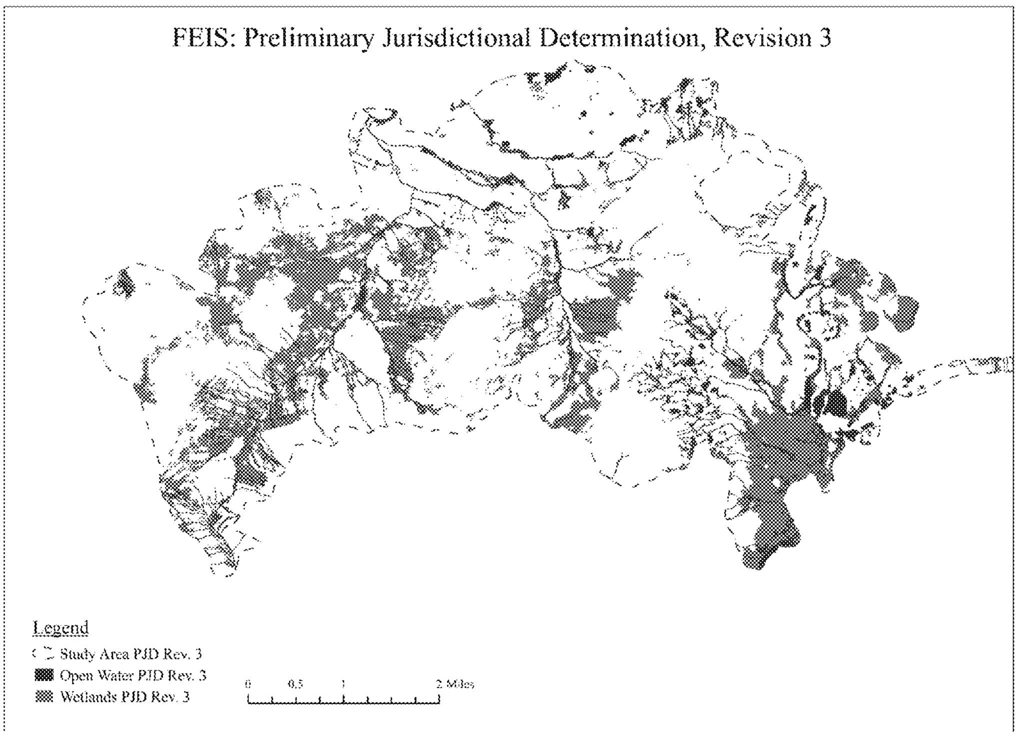
[5] Yocom, Thomas G. 2018. Questioning the Corps' Preliminary Jurisdictional Determination for POA-2017-271. Report Prepared for Earthworks. June 17, 2018. 11 pages, plus figures and appendix.

[6] It is a fine point, but the applicant has no authority whatsoever to make a "determination" of jurisdiction. Only the Corps or EPA can make those determinations under Section 404 of the Clean Water Act. Applicants or their consultant agents can "delineate" the boundaries of wetland and aquatic areas following federal methodologies, but these delineations can only be "determined" to be jurisdictional by the Corps or EPA. Here the Corps made such a determination on the basis of a desk review of the applicant's delineations. To the author's knowledge, no wetland/upland boundaries were actually field verified by the Corps or EPA.

[7] Nationally, the Corps' written form accompanying its preliminary jurisdictional determinations states: This preliminary JD finds that there *"may be"* waters of the United States on the subject project site, and identifies all aquatic features on the site that could be affected by the proposed activity, based on the following information:" (underline added for emphasis) (see http://www.spl.usace.army.mil/Portals/17/docs/regulatory/JD/AJD/JD_PJD form.pdf)

Figure 1. Comparison of the Corps Alaska District's assertion of jurisdiction over wetland and aquatic areas at the Pebble Mine site in its DEIS and FEIS.





vegetation communities it claimed it could precisely distinguish in its aerial photographs. This included many specific communities within which the applicant's various consultants between 2004 and 2017 had confirmed a mix of unregulated uplands and regulated wetlands (areas referred to as mosaics).

Under the rules for a preliminary jurisdictional determination (see footnote 7 above), areas that "may be" wetlands are to be considered jurisdictional for the purposes of permitting pursuant to Section 404 of the Clean Water Act. Accordingly, any such vegetation community mosaics where the wetland components could not be distinguished from the upland portions using remote sensing should have been determined to be jurisdictional pursuant to Corps policies. Otherwise, PLP would have been required to completed a formal jurisdictional delineation to map and field verify the actual boundaries of all wetland areas within all vegetation communities. The applicant opted for the preliminary jurisdictional determination, recognizing that the wetland acreage would likely be an overestimate.

Inappropriately, PJD#3 continues to rely upon the outdated observations and methodologies that flawed PJD#1, even though PLP claims its 2018 field data are sufficiently robust and distributed among the varied landscape positions and underlying soil associations to allow PLP to use the same aerial photography to distinguish uplands from wetlands within all of its vegetation community mosaics, many of which were changed in the FEIS from 100% wetlands to 100% uplands – the elimination of vast areas of "mosaics" as wetlands accounts for most of the wetland acreage differences between the DEIS and FEIS (Figure 2). Simple inspection of the maps provided in the DEIS and in FEIS-related files suggests that the field work performed in 2018 and 2019 was hardly extensive, nor did it cover the full range of landscape and underlying soil profiles to allow the wholesale extrapolation that led to the enormous reduction of mapped wetlands between the DEIS and the FEIS.

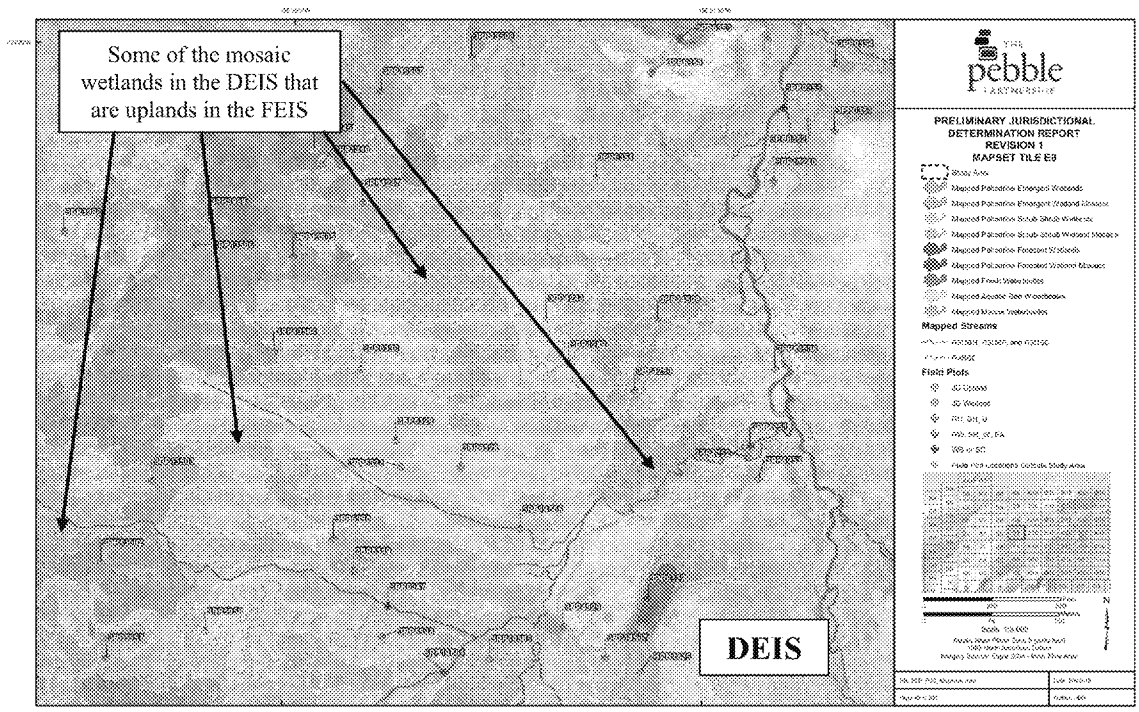
Furthermore, there is no evidence presented in PJD#3 that PLP or the Corps did any actual on-the-ground field verification of the actual wetland/upland boundaries within any of the former mosaic areas that it now claims are 100% upland.

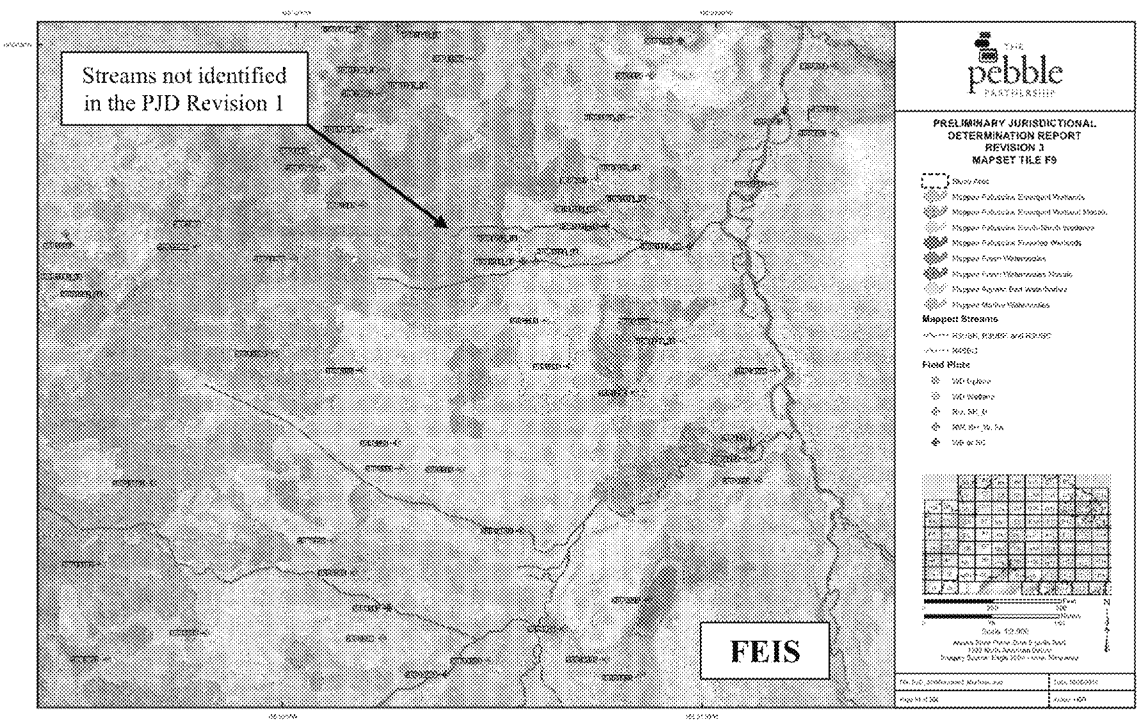
The direct project impacts to wetland and aquatic areas under PJD#1 (as disclosed in the DEIS) were 3560 acres of direct impacts, 2345 acres of indirect impacts, and 510 acres of up-to-one-year temporary impacts. Under PJD#3, the impacts disclosed in the FEIS were reduced to 2231 acres of direct impacts, 1609 acres of indirect impacts, and 773 acres of "temporary" impacts (see FEIS Table 4.22-1, page 4-22.15). The difference in direct impacts alone between the DEIS estimate and the FEIS estimate is over 2 square miles (1329 acres).

The applicant's introduction of a significantly smaller project study boundary in PJD#3 serves to complicate the analysis, as well as to reduce the usefulness of the overall mapping effort insofar as the NEPA analysis is concerned. The study area in the DEIS was 44,562.58 acres, whereas in the FEIS it has shrunk to 33,939.97 acres.

The new study boundary hugs the edge of the Pebble Project footprint, which might be appropriate for making a final determination of Clean Water Act jurisdiction pursuant to Section 404, but only if and when a permittable project footprint has been identified. However, at this

Figure 2. Areas determined to be jurisdictional wetlands in the Pebble Mine DEIS compared with those in the FEIS. Most wetland-upland mosaics were changed from 100% wetlands to 100% uplands with no field verification or updated sampling (data points identified as HDR.xxxx_18), reducing the mapped wetlands by over 1300 acres.





juncture, the truncated project study area unreasonably limits the depiction and disclosure under NEPA of the surrounding areas with regard to potentially less environmentally damaging sites

wherein various project facilities could potentially be reconfigured to further avoid impacts to wetland and aquatic habitats. This is particularly true for the northern transportation corridor which is simply presented as the only possible alignment for that roadway without any evidence that the alignment was tailored in any way to avoid impacts to wetland and aquatic areas.

This limitation of showing only the wetlands and uplands within the applicant's preferred footprint provides the Corps and the public with no reason to conclude that the preferred footprint is the least environmentally damaging practicable alternative. It also does a great disservice to the analysis of reasonably foreseeable future actions – specifically, the inevitable expansion of the Pebble Mine to more fully exploit the ore deposit.

PJD#3 suffers from similar problems that were described for PJD#1.[8] Many field sites where the applicant's consultants recorded strong field indicators hydrophytic vegetation and wetlands hydrology were dismissed as meeting the criteria for wetlands, when those field indicators should have led the delineators to conclude that the mandatory criteria for vegetation, hydrology, and hydric soils were, in fact, met (Figure 3).

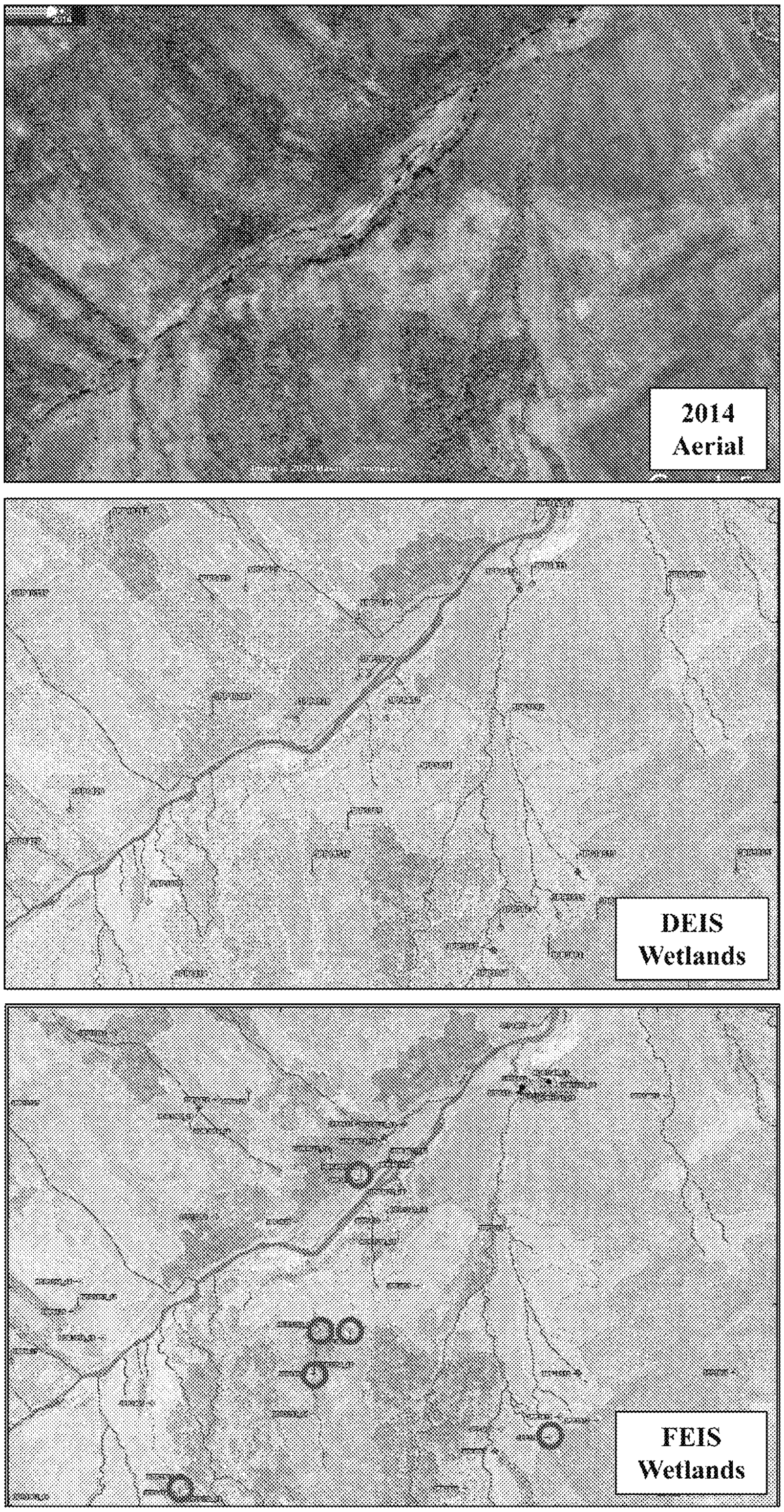
Direct observations of inundation, saturation to the surface, and oxidized rhizospheres were dismissed as being the result of above average rainfall as measured at a gauging station 18 miles away whose rainfall records there are significantly different from the Pebble mine site.[9] Even if the rainfall was above average at the mine site,[10] no effort was made to determine whether the same field sites would be inundated or saturated to the surface for 14 or more consecutive days during the growing season in most years – in other words, meeting the federal criteria for hydrology and hydric soils in jurisdictional wetlands.

The applicant similarly had dismissed strong field indicators of hydrology at many field sites in PJD#1, but without any claim that the inundated or saturated conditions were abnormal. And interestingly, PLP's 2018 field data show that some areas where it concluded that wetlands were, in fact, present on the basis of organic soil horizons, the water table was well below that which PLP observed during the same time period at sites it determined to be "uplands," claiming the conditions were abnormally wet.

Moreover, in its 2019 field work, PLP field investigators reported that their observations were made during significant drought conditions, but its investigators made no apparent efforts to determine how to correct its observations for normal hydrology – including the 1987 Corps Wetland Delineation Manual recommendations for revisiting the sites when normal conditions (51 out of 100 years) are present during the growing season. The Corps appeared to make no

[8] Yocom, Thomas G. 2018. Questioning the Corps' Preliminary Jurisdictional Determination for POA-2017-271. Report Prepared for Earthworks. June 17, 2018. 11 pages, plus figures and appendix.
[9] Stratus Consulting, Inc. 2010. Hydrologic Analysis of the Pebble Deposit Area, Alaska. Report prepared for The Nature Conservancy, Anchorage, Alaska. August 27, 2010. 73 pages.
[10] In the case of the Iliamna Airport gauging station, it recorded less than 5 inches more rainfall in 2018 than in an average year, about a 19% increase in overall yearly rainfall.

Figure 3. Comparison of wetlands mapped in the DEIS and FEIS for the Pebble Mine Project, as shown within Map Tile H5 (PJD Rev 3). Circled field sites were determined to be uplands by the Corps of Engineers despite strong field indicators for wetlands hydrology and hydrophytic vegetation.



requests for any such corrections from the applicant on its rush to complete the FEIS and, presumably, to quickly issue a record of decision (Figure 4).

The Alaska Regional Supplement to the Corps Wetland Delineation Manual cautions that areas lacking hydric soil characteristics can nevertheless meet the criteria for wetlands if the soil is inundated or saturated for 14 or more consecutive days during the growing season. The Alaska Supplement notes that this condition can exist in areas where there is a restrictive layer in the soil profile that creates a perched water table. The Supplement states that field investigators must dig their soil pits at least 24 inches deep to determine if such a restrictive layer is present, as wetland conditions can occur even in sandy and cobbled soil profiles over an underlying restrictive layer. PLP's recent field data indicate that none of the soil pits were dug to appropriate depths to make such determinations.

Similarly, although the field work completed in 2018 and 2019 (the latter, primarily within the proposed transportation corridors) are considered appropriately contemporary for a Corps determination of jurisdiction on December 6, 2019,[11] the wetland maps continue to include and strongly rely upon outdated and uncorrected field observations made in 2004-2008 (including all but one of the 48 Vegetation Classification Photographic Signatures upon which the applicant's wetlands mapping relies[12]). It also appears that PLP made no effort to make after-the-fact corrections to the underlying data forms, if only to update them to be consistent with the present-day delineation methodologies for Alaska[13] (including updating the indicator status of the vegetation) nor (with a few exceptions) to revisit its same field sites sampled in 2004-2008 upon which it continues to rely, in order to reaffirm or change the field indicators at those sites.

Finally, in 2011 when the applicant, then known as the Pebble Partnership, was, as yet, unwilling to share the underlying data for its wetlands mapping efforts, its consultants did estimate that their delineation efforts had found that one third (33.4%) of the area within their mine study area was jurisdictional wetlands and aquatic areas, 96% of which was wetlands, with 4% open water bodies;[14] using these estimates, the percentage of wetlands alone was 32% of the study area. Within the northern transportation corridor, which the Pebble Partnership favored at that time,

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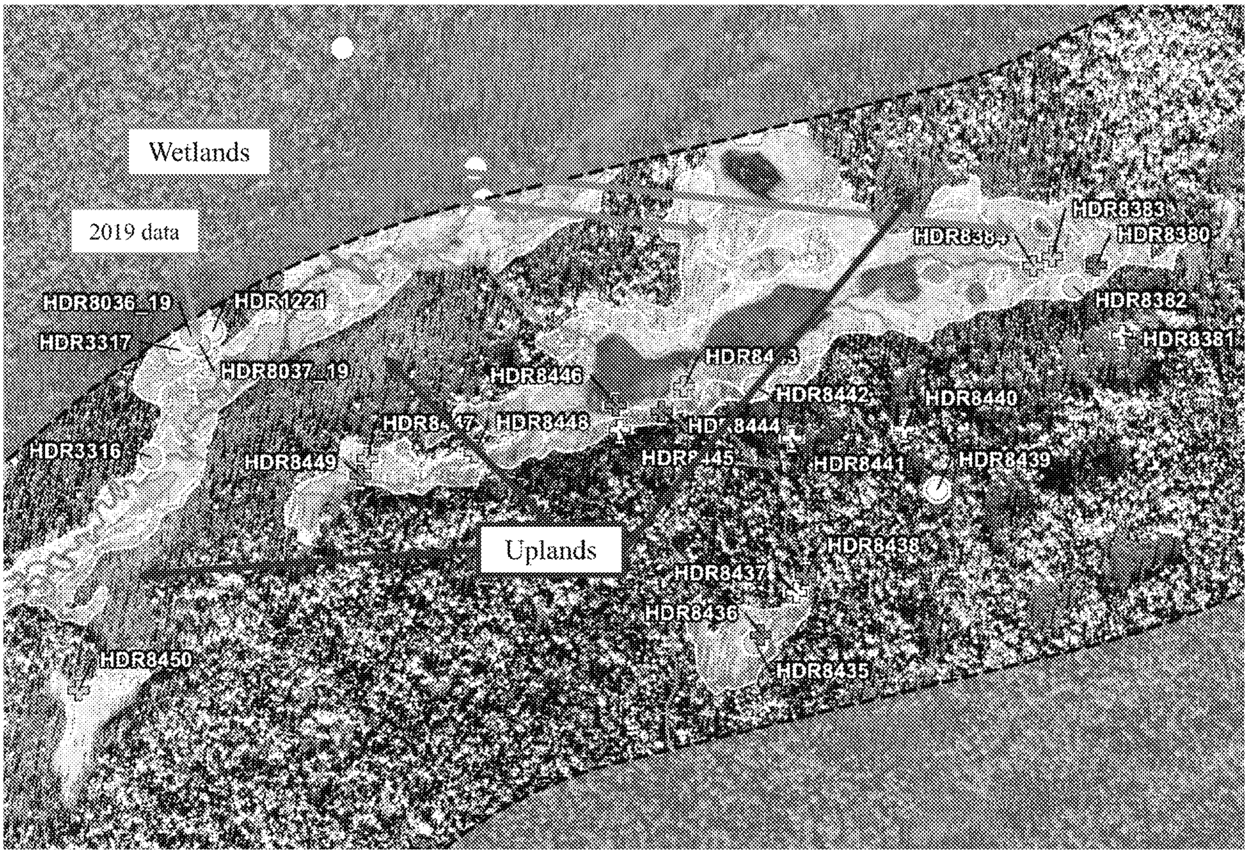
[11] See Pebble Project, Preliminary Final Environmental Impact Statement, Appendix J.

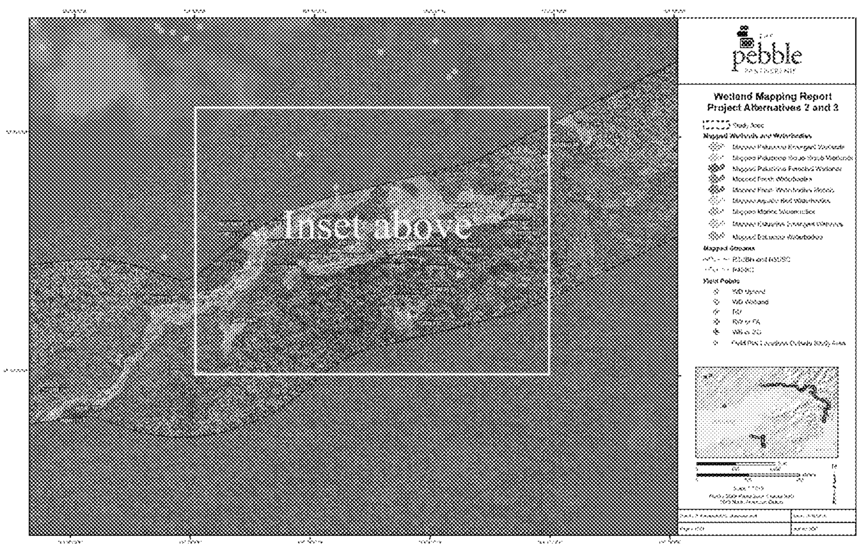
[12] Wetland mapping in PJD#1 and PJD#3 rely on identification of the discrete boundaries (polygons) of 48 vegetation communities in aerial photographs. The reference photographs in PJD#1 and PJD#3 are unchanged, and some are nearly 20 years old. PJD#1 identified wetland, upland, and mosaics of wetlands and uplands within many of 48 vegetation communities. PJD#3 eliminates most mosaic areas, using the same reference photographs. PLP claims it can now discretely distinguish between jurisdictional wetlands and unregulated uplands within every one of its delineated polygons, and the Corps has agreed and adopted these revisions.

[13] Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region (Version 2.0), ERDC/EL TR-07-24, September 2007.

[14] "*In total, 29,429.7 acres were mapped in the mine mapping area depicted on the overview map for Figure Series 14.1-3. Of that mapping area, 9,825.7 acres, or approximately 33.4 percent, were mapped as wetlands or waters (Table 14.1-5). Of the wetlands and waters, 8,650.4 acres, or 29.4 percent of the mine mapping area, were mapped as wetlands, and 1,175.3 acres, or approximately 4.0 percent of the mine mapping area, were mapped as open-water habitats. In addition, 19,604.0 acres, or approximately 66.6 percent of the mine mapping area, were mapped as uplands (i.e., non-wetlands).*" Three Parameters Plus, Inc. and HDR Alaska, Inc. 2011. Pebble Project Environmental Baseline Document 2004 through 2008: Chapter 14. Wetlands and Waterbodies, Bristol Bay Drainages. The Pebble Partnership. September 8, 2011. Page 14-23. Available at: https://pebbleresearch.files.wordpress.com/2014/03/ch_14_wetlands_bb.pdf (last accessed, August 16, 2020).

Figure 4. Similar vegetation signatures on the northern transportation corridor were determined by the Corps, Alaska District, to be wetlands in some cases and uplands in others. Only 2 of 33 data points on Map 2 of 61 (lower figure) are from 2019, whereas all others are outdated. The 2 updated field sites are wetlands, but were mapped as uplands in 2004 and 2005 (HDR1221 and HRD3317). The Corps should have updated all mapped areas.





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HDR reported that 12.2 percent of the study area was wetlands and open-water bodies. Acreages or linear measures of streams were not provided.[15]

For a Corps Preliminary Jurisdictional Determination (PJD), all mosaics are to be considered jurisdictional "waters of the United States," including wetlands. The numbers reported in the Pebble Partnership's voluminous Environmental Baseline Document in 2011 were its estimates of the actual reach and extent of jurisdictional waters, and not the overestimates that are expected when wetland-upland mosaics are considered 100% wetlands in a PJD.

It is very important to distinguish these differences, as they can be confusing. As stated earlier, in their field work, PLP's wetland consultants estimated that certain vegetation communities that they could also identify and map in aerial photographs included wetlands as well as uplands to greater or lesser degrees. The consultants adopted mapping protocols that gave numerical codes to those vegetation communities with the approximated ratio of wetlands to uplands therein.[16]

Here is a simplified example of how that a PJD is supposed to work. Assume there is a 400-acre parcel made up of four different vegetation communities, each of which occupy 100 acres. Wetland delineators have sampled within each of the four communities and determined one is 100% wetlands, one is 100% uplands, and the remaining two 100-acre communities are mosaics of 50% and 10% wetlands, respectively.

The wetland delineators estimate that the true reach and extent of wetlands on this 400-acre is 160 acres (100+0+50+10 = 160), and that the site, overall, is 40 percent wetlands (160÷400). That 160-acre number and 40% percentage is the equivalent of what the Pebble Project consultants reported in 2011 as the 9,825.7 acres of wetlands, and approximately 32% wetlands it mapped within its mine site study area (see footnote 14, above).

Under the Corps' rules for a Preliminary Jurisdictional Determination, the 400-acre parcel in the example above would have yielded a 300-acre determination of jurisdiction, as all mosaics are supposed to be considered 100% jurisdictional wetlands under a PJD. This would make the parcel 75% wetlands (a 140-acre overestimate), but that is a necessary downside of moving forward with a PJD, rather than a formal field delineation of the actual boundaries of all wetland areas within a large complex site. The benefit to the applicant is that permit processing can move forward far more quickly, and the costs of a comprehensive delineation of all the wetland boundaries can be avoided.

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[15] "*In the transportation-corridor mapping area, 2,425.6 acres were identified as wetlands or waterbodies; thus, approximately 12.2 percent of the transportation corridor mapping area is wetlands or waterbodies.*" (Three Parameters Plus, Inc. and HDR Alaska, Inc. 2011. Pebble Project Environmental Baseline Document 2004 through 2008: Chapter 14. Wetlands and Waterbodies, Bristol Bay Drainages. The Pebble Partnership. September 8, 2011. Page 14-23. Available at: https://pebbleresearch.files.wordpress.com/2014/03/ch_14_wetlands_bb.pdf (last accessed, August 16, 2020).

[16] "*The percentage of upland versus wetland was also noted and documented in the following groupings, retained in the attributes of the GIS data provided to USACE: U_10 (10 percent wetland); U_20 (20 percent wetland); U_40 (40 percent wetland); W_10 (10 percent upland); W_20 (20 percent upland); W_40 (40 percent upland). For the purposes of this PJD, all polygons mapped as mosaics were considered 100 percent wetland or waterbody when determining acreages (Section 5.0).*" Pebble Project Preliminary Jurisdictional Determination Report (Revision 1). Prepared for U.S. Army Corps of Engineers – Alaska District, Regulatory Division. Prepared by HDR. January 2018. Page 16.

The purpose of this example, however, is to cast doubt on the veracity of the Corps' Preliminary Jurisdictional Determinations, which have resulted in reductions well below what would have been expected on the basis of the applicant's own estimates of the actual reach and extent of jurisdiction on the basis of its 2004-2008 field studies, particularly because those same field studies make up the bulk of the data upon which the PJD's are based. And, given that the size and boundaries of the mine site study area and transportation corridor have repeatedly changed in PLP's project maps, it is really only possible to compare these studies on the basis of the overall percentages of wetlands, as these are less likely to vary to the same degree as when the applicant and Corps change the overall size of the study area.

The Corps' PJD for the DEIS adopted PLP's Revised Preliminary Jurisdictional Determination of January 2018. That study found:

> *"Overall, wetlands totaling 10,039.0 acres were identified in the study area."*[17]
>
> *"For the purposes of this PJD, all polygons mapped as mosaics were calculated as 100 percent wetland or waterbody when determining acreages. In total, 15,185.3 acres, or 34 percent of the study area, are preliminarily determined to be waters of the U.S., including wetlands, and are assumed to be subject to USACE jurisdiction."*[18]

Focusing on the reach and extent of wetlands alone (10,039 acres), rather than including open-water bodies, the percentage of the study are determined to be wetlands (supposedly including 100% of the wetland-upland mosaics) was 22.5% ($34 \div 15{,}185.3 \times 10{,}039 = 22.5\%$). There is little reason to expect the overall estimates of wetland acreage or percentages to drop when wetland-upland mosaics are considered 100% wetlands.

Previously, the author strongly questioned the PJD (Revision 1) that the Corps relied upon in the DEIS in quantifying project impacts to wetland and aquatic areas.[19] And, when the applicant updated its estimates following the release and comment period for the DEIS, the estimates of wetlands dropped further to approximately 14.3% the study area[20] (again, supposedly an overestimate that considers mosaics to be 100% wetlands).

The result of the Corps' acceptance of these new estimates was a reduction in jurisdictional acreage of over 2 square miles, giving a completely false impression to readers of the FEIS that the project had been modified to reduce its impacts.

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[17] Pebble Project Preliminary Jurisdictional Determination Report (Revision 1). Prepared for U.S. Army Corps of Engineers – Alaska District, Regulatory Division. Prepared by HDR. January 2018. Page 23.

[18] Pebble Project Preliminary Jurisdictional Determination Report (Revision 1). Prepared for U.S. Army Corps of Engineers – Alaska District, Regulatory Division. Prepared by HDR. January 2018. Page 24.

[19] Yocom, Thomas G. 2018. Questioning the Corps' Preliminary Jurisdictional Determination for POA-2017-271. Report Prepared for Earthworks. June 17, 2018. 11 pages, plus figures and appendix.

[20] "*In total, 8,691.6 acres, or 26 percent of the study area, is preliminarily determined to be waters of the U.S., including wetlands, and is assumed to be subject to USACE jurisdiction.*" Of this total, PLP estimated that 4,774.6 acres were wetlands, or 14.28% of its study area. Revised Report Pebble Project Preliminary Jurisdictional Determination Report. Revision 3. Prepared for U.S. Army Corps of Engineers – Alaska District, Regulatory Division. Prepared by HDR. November 2019. Page 26.

Acreage estimates for the transportation corridor are not possible to compare directly, as the most recent estimates (2019) include open water areas of Cook Inlet, and the study areas are different than in previous studies.[21] Again, it is more appropriate to compare the estimated percentages of wetlands (without consideration of the open water, including tidal areas) within the varying study areas as a measure of how the progression of the applicant's field studies have changed the perception of the impacts within the proposed northern transportation corridor for the Pebble Mine Project.

In 2011, the Pebble Partnership reported:

> *"In the transportation-corridor mapping area, 2,426 acres, or approximately 12 percent of the total mapping area, were mapped as wetlands and waters (Table 14.2-3). Areas mapped as wetlands comprised 1,783 acres, or approximately 9% of the transportation-corridor mapping area.)"*[22]

Considering only wetlands and not open-water habitats, the most recent PJD revision for the transportation corridor determined that only 5.4% of the 16,671.4-acre study area (893.6 acres) is wetlands (including wetland-upland mosaics).[23]

Conclusions

In summary, the applicant's estimates of jurisdictional wetlands (and presumably other "waters of the United States) have continued to be revised downwards in increasingly dramatic fashion since its studies were begun in 2004. The overall estimate of the percentage of wetlands in the vicinity of the mine site has progressively dropped from 32% in 2011 to 14.3% in the FEIS. Similarly, the estimates of wetlands within the transportation corridor have dropped from 9% to 5.4%, and, as with the mine site study area, the early estimates did not treat mosaics as 100% jurisdictional wetlands, as is required in a Corps PJD.

The Corps' own 2019 and 2020 Preliminary Jurisdictional Determinations are "mosaics" of outdated or incorrect field observations, insufficiently broad recent observations, questionable conclusions about hydrology, and varying study boundaries. But for a 3-day tour for Corps and EPA staff, there is no evidence that any trained delineators for either the Corps or EPA actually field verified any mapped boundaries or the field data that are used in the DEIS or FEIS to quantify the direct, indirect, and/or temporary impacts of the proposed Pebble Project to the "waters of the United States," including wetlands.

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[21] Pebble Project Wetland Mapping Report Project Alternatives 2 and 3. Prepared for Pebble Limited Partnership, LLC. Prepared by HDR. November 2019.

[22] Three Parameters Plus, Inc. and HDR Alaska, Inc. 2011. Pebble Project Environmental Baseline Document 2004 through 2008: Chapter 14. Wetlands and Waterbodies, Bristol Bay Drainages. The Pebble Partnership. September 8, 2011. Page 14-33. Available at: https://pebbleresearch.files.wordpress.com/2014/03/ch_14_wetlands_bb.pdf (last accessed, August 16, 2020)

[23] Pebble Project Wetland Mapping Report Project Alternatives 2 and 3. Prepared for Pebble Limited Partnership, LLC. Prepared by HDR. November 2019. Page 10.

The public should place little confidence that the Corps has provided it with a credible determination under NEPA that it has fairly disclosed the full extent of the potential impacts of the Pebble Mine Project to the thousands of acres of the "waters of the United States," including wetlands, that the project would destroy.

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"Technical Support for Grassroots Public Interest Groups"

April 20, 2020

Jennifer Weiss, Trout Unlimited
Jennifer.Weiss@tu.org

cc: Dave Chambers (dchambers@csp2.org), Ann Maest (aamaest@gmail.com), Andre Sobolewski (andre@clear-coast.com)

Re: USACE responses to comments on Pebble DEIS on discharge of selenium

Introduction

In April 2019, a technical team of 6 authors submitted a joint comment paper on the risks to birds, fish, and wood frogs from likely discharge of high concentrations of selenium from the water treatment plant, and related increase in water temperature at the discharge location. This general paper was followed by specific and detailed comments from Ann Maest (re pit lake concentrations of selenium likely to be higher than the DEIS anticipates), from Andre Sobolewski (on the likely inability of the water treatment plant to reduce selenium to safe or legal levels), from Gordon Reeves (on likely impact of warm water at discharge site), and from Chris Frissell and Sarah O'Neal (on bioaccumulation) which they have, or presumably will provide their comments on USACE responses in separate memos. As the lead author of the memo, I provide here a high level overview of the USACE responses that addresses key failings of the PFEIS in responding to concerns.

DEIS Issue: Inadequacies of Water Treatment Plants (WTPs)

This issue combines several comments submitted by Tech Team members, including issues of discharge of high selenium (with impacts to local fish, frogs, and birds), discharge of warm water (with impacts to fish), and pit lake water quality. There is reason to believe that selenium concentrations entering the Pebble WTP will be higher than modeled, that the plant itself will not be able to treat the very high volumes of water expected, and as a result high selenium will be discharged in wastewater, with effects locally on aquatic life, including fish, frogs, and birds. (PFEIS Appendix D)

FEIS response

1. All water that is discharged from the wastewater treatment plants will be required to meet Alaska water quality criteria.
2. The water treatment process design will continue as the project advances, and would be required to comply.

Comment

The authors of the PFEIS did follow up to request additional information from PLP, SRK, and Knight-Piesold between November 2011 and March 2020. The main points to take away:

1. **Proprietary models allowed.**
    a. **Proprietary models were applied, such that it is difficult for independent reviewers to repeat the work.**

Specifically, the MetSim mill process model was used to inform the GoldSim model to determine whether salts would build up on the WTP equipment, causing it to be less efficient or fail (RFI 021h).

b. **Co-reliance of four different consultants could lead to "finger-pointing"**
To determine whether the wastewater discharged would meet water quality, PLP relied on four consulting firms. SRK did geochemistry testing on ore and other rock "to inform water treatment technologies". HDR dealt with what goes on inside the water treatment plant while Knight-Piesold dealt with what goes on outside the water treatment plant (site water balance, water quality at different locations around the mine). Lorax specifically looked at water quality in the pit lake over time.

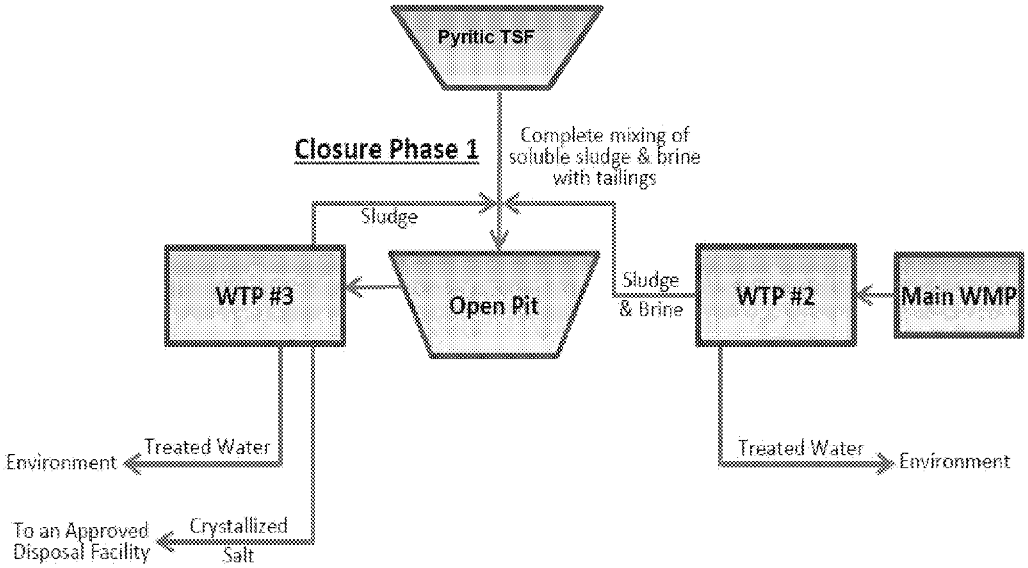
The problem is that if all of the methods and models applied by all four are not transparent or in the public domain, there is no way that regulators or independent consultants can verify the work by any one group. We also do not know if any group is re-running methods by any other group, or just relying on the inputs they are given. For example, Knight-Piesold relies on SRK's geochemistry and HDR's model of character of the brine waste that leaves the water treatment plant to go to the pyrite tailings facility as inputs in their site-wide water balance and water quality.

The inability to redundantly confirm results is dangerous, and combined with the use of four different firms means that it is possible no one will become the responsible party if results are wrong.

2. No repercussions for false or misleading information.
In response to our comments, the PFEIS authors requested information of the concentration of constituents at each part of the treatment process in the WTP so they could follow where each was being removed. They also requested information on maintenance procedures, consumables, and how water temperature would be lowered before discharge.

a. **The expected reliance of the DEC APDES wastewater permit on the FEIS creates a permitting failure point.** PLP's response was that they wouldn't know any of this until pilot plant testing, which would be done for the APDES permit. However, in our experience, the APDES permit relies heavily on the FEIS. The authors of the PFEIS could insist that pilot plant work be completed before the FEIS is written, but they have not taken that step.

b. **New waste products.** As a result of some Tech Team comments, HDR and Knight-Piesold re-ran models and determined that if salt were to build up in the WTP, it would occur at WTP #2 in the first closure phase (RFI 021e Appendix B and C and RFI 021i). Yet one of the primary changes was the addition of plans for a "brine evaporation/ crystallization" system to WTP #3 "if needed" (RFI 021e) due to salts re-mobilized when pyrite tails are moved to the pit, which would not affect WTP #2, and this is why the brine evaporation step was added, which will crystallized salt – an estimated 6,000 lbs per year of which would then need to go to "a facility for disposal" (RFI 021h, see image). There are no details on where this material will be disposed.



3. Regulatory failure to apply oversight

There is no mine in the world that is currently attempting to treat volumes of water as high as Pebble will expect. This is not made clear in the PFEIS. Instead, the caveat has been added "The information provided is at a conceptual stage of development, and there is limited ability to identify potential significant technical failures of the treatment strategy. The technical viability of the WTPs would require further evaluation during the permitting phase." Instead of vague language, a pilot plant should have been ***required*** before the PFEIS was allowed to be completed. This would have provided better information on salt buildup and plant efficiency, and details of disposal locations for waste products, such as salt, would have been included in a PFEIS. While there may be issues with modeling by individual consultants, the failure to require a pilot plant is a failure at the regulator level.

DEIS Issue: Pit lake water quality

DEIS Criticism: Acidic water in the pit lake

The Pebble DEIS predicts neutral to alkaline (pH ~ 8) water in the pit lake. Maest and Wobus counter that this is highly unlikely with the acid – generating material of the deposit. An acidic pit lake could result in bird deaths, as is seen at the Berkeley Pit in Montana.

FEIS response

In responding to concerns about birds, the USACE responds (PFEIS pD-15) that they updated PFEIS Section 4.23 to show the differences between the Berkeley Pit and Pebble pit lake; however, this language continues to predict neutral pH in the Pebble pit lake, and does not explain why neutral pH will occur in a deposit of acid-generating rock.

Comment:
This goes back to the issue of whether models can be re-created by independent consultants. Information from all four of the consultants, as well as by a fifth (BGC) working on groundwater and dewatering, is important to determining pit lake water quality. In updated models, based on SRK, HDR, and Lorax inputs, Knight-Piesold specifically provides a footnote that they did not model the pH (RFI 021e Appendix B and C). The PFEIS does replace a non-public modeling code for groundwater hydrology (used by Piteau Associates) with a public USGS code (used by BGC) – they could require public codes be used for water quality modeling as well (PFEIS p2).

Summary/Conclusions

We continue to expect that selenium at the point where the water treatment plant discharges to be high in selenium – greater than state water quality criteria and high enough to have ecotoxic effects locally. I have provided these as a birds-eye view and example of the way that the process is broken. Although EIS authors attempted to obtain information to answer our questions, they stopped short of obtaining relevant answers. Instead of working through substantial issues – which would require investments of time and money, but which would provide more reliable information on the most critical and longest-standing component of the mine facility – issues were kicked down the road with vague assurances.

Regards,

Kendra Zamzow

Kendra Zamzow, PhD

May 30, 2019
US Army Corps of Engineers
Shane McCoy, Project Manager
http://www.poa.usace.army.mil
(907) 753-2712

Re: Fugitive Dust issues in the Pebble Project draft EIS

Dear Mr. McCoy:

Please find attached our memo on fugitive dust from the mine site, which lays out our concerns with respect to the lack of analysis of fugitive dust sources, deposition rates, chemistry, and most importantly the environmental consequences. We believe there is a significant risk of ecotoxic effects from trace metals, particularly impacts of copper on fish as it leaches from massive volumes of dust, annually, for decades. Additionally, the cascading effect of multiple stressors is biologically critical.

These risks must be considered in the Final EIS.

Thank you for this opportunity to comment.

Kendra Zamzow
Kendra Zamzow, PhD, Environmental chemist
Center for Science in Public Participation

Ann Maest
Ann Maest, PhD, Geochemist
Buka Environmental

Christopher A Frissell
Chris Frissell, PhD, Fisheries and aquatic ecology
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Sarah O'Neal
Sarah O'Neal, Fisheries biologist
PhD student, University of Washington

<u>Key comments</u>
We provide here a summary of key comments, deficiencies and of actions that need to be performed. We believe these should be addressed in a Revised DEIS.

Copper, which is toxic to aquatic life and which will be entrained in dust, was not recognized as a component of fugitive dust nor included in assessments of impacts, therefore environmental consequences to aquatic life are insufficient. This is a major failing of the DEIS. There is also no recognition of sources of copper, zinc, and other metals from vehicle wear and tear or tailings beaches that may add to the total concentrations.

The "impact" of fugitive dust consists of a list of acres or vegetation, wetlands, and water bodies that could have dust settle on them. This is likely an underestimate of the plume deposition area, if the soil is lighter, due to the amount of silt, than considered in the calculations. There is also an estimate of the increase in metal concentrations in soil for air pollutants hazardous to human health – but this not only omits copper, it omits any analysis of the change in concentration in water bodies such as ponds, where metals may accumulate in sediment over time. This is insufficient for an environmental consequences analysis.

The DEIS unrealistically and without evidence assumes that dust at the mine site will be controlled with water, and does not consider the impact of chemical dust suppressants such as salts either to areas within the main mine area footprint or in the dust plume as suppressants dry and become entrained in fugitive dust.

Lastly, there is virtually no baseline against which to compare future concentrations of metals in the dust deposition zone, therefore there would be no way to determine whether concentrations were increasing or the rate of increase due to mining activities. There are very few soil sample sites in the mine area and no description of the wetlands and water bodies within the deposition zone, which should include ephemeral ponds as well as large, permanent lakes. The DEIS information is too limited for the reader to determine whether wetlands and water bodies have baseline trace element analysis of sediment, water, and vegetation.

The failures listed above represent major deficiencies that, if left unaddressed, will result in seriously underestimating the ecological consequences of the project.

Actions required
The following, by category, are actions that should be performed prior to the release of the final EIS.

<u>Missing data</u>

- Critical model inputs for determining dust deposition rates and accumulated metal concentrations must be supplied in a Revised DEIS.
- The full likely suite of major chemical components of fugitive dust must be identified and accumulated concentrations determined for the 20-year and 78-year mine scenarios.

- Baseline soil and sediment data, including trace element chemistry, sufficient to determine future impact must be collected and presented in context such that the reader can determine what sites within the deposition zone have baseline.

Ore concentrate

- Provide information on the volume of ore concentrate contributing to the mine site dust plume, the concentration of copper in ore concentrate, and anticipated mitigation measures to reduce dust from the ore concentrate storage and loading zones.

Wind speed and precipitation

- All available data on wind, particulate, precipitation, and other relevant data from meteorological stations should be utilized in fugitive dust modeling.
- Explain why precipitation data from all meteorological stations at Pebble were not utilized. Justify the assumptions that went into the analysis that dust would be greatest in summer.
- Provide information and maps on the likely extent of fugitive dust deposition from the mine site before and after mitigation for summer and winter.

Volumes of dust

- Explain why the threshold velocity for tailings to become wind-borne is the same velocity as for aggregate (1.06 m/s) (RFI 007 Appendix A-3 Table 8).

Chemical dust suppressants

- Provide examples of mine sites in similar climates that have controlled dust to a high degree through watering alone, and information to support the assumption that dust control is not needed in winter.
- If examples cannot be provided, add analysis of alternatives for dust suppression and their potential impacts on wetlands, water bodies, vegetation, fish, and wildlife through wind and water dispersion.

Impacts to wetlands, ponds, and streams

- Components of fugitive dust, the known landscapes that dust will enter, and likely biogeochemical cycling need to be tied together with an ecological analysis to provide context for the proper assessment of risks to fish, aquatic life, and birds.

Impacts of trace metals on fish and wildlife

- Impacts to fish and wildlife need to consider exposure to fugitive dust components through inhalation, ingestion, and prey consumption. Bioaccumulation and trophic transfer effects must be considered to assess potential impacts.

Executive Summary

Fugitive dust – windblown material from the mine site – is an acknowledged risk in the Pebble Project Draft EIS (DEIS). However, the DEIS assessment of this risk is inadequate because it is disjointed, fragmented, incomplete, and relies on inaccurate assumptions. The extent of the area impacted by dust may be higher than modeled. Discussion of impacts (e.g. to birds, soil, vegetation) are fragmented across multiple chapters and not put in meaningful context.

Importantly, copper is likely the most abundant ecotoxic contaminant in fugitive dust from the mine, but we find no recognition whatsoever of the copper content in an estimated 8,300 tons of fugitive dust that will blow off the mine site annually nor any analysis of copper concentrations as fugitive dust accumulates in soil and water bodies for the 20- to 78-year mine scenarios. Therefore the DEIS severely underestimates the immediate and cumulative ecotoxic effects of fugitive dust on fish and aquatic life.

Introduction

Fugitive dust refers to particulate matter suspended in air. Originating from disturbed soils, waste piles, and unvegetated surfaces at mine sites, quarries, and roads it provides a means for transport of pollutants away from the mine into the surrounding environment (Cecala et al. 2012). Mining activities generate dust by stripping vegetation, draining soils, and grinding and crushing mineral particles on driving surfaces (Thompson and Visser 2007). Dust is also generated through blasting and drilling, transport and erosion of stockpiled ore and overburden, and through wind erosion of tailings beaches. Haul trucks can generate the majority of PM10 particulates[1] at mine sites (Cecala et al. 2012, Chapter 10; RFI 007 Appendix A-3 Table 1a) (Figure 1).

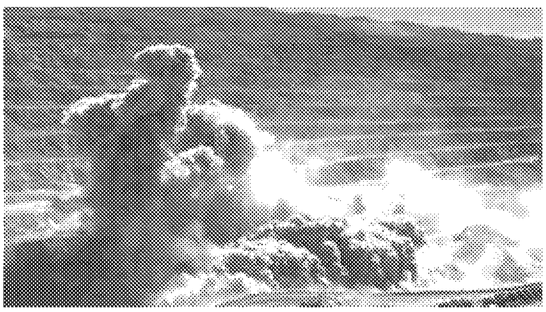

Figure 1a. Fugitive dust from blasting. *Source: http://www.savethesantacruzaquifer.info/dustissues.htm*

Figure 1b. Dust generated by haul truck. *Source: Cecala et al. 2012*

[1] PM10 refers to particulate matter that is very small, 10 μm size or less. This size is generally a health concern when inhaled.

The environmental impact of fugitive dust from the mine site includes an increase in turbidity in waters, smothering of vegetation, and early snowmelt due to dust on snow surfaces. Trace metals, particularly metal sulfides, entrained in dust may leach out over the thousands of acres of vegetation, wetlands, and water bodies expected to be in the dust deposition zone at the Pebble Project, leading to ecological effects.

The following element symbols are used in this memo: antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), Fe (iron), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni), sulfide (-S), selenium (Se), zinc (Zn).

Source of fugitive dust

The DEIS recognizes that fugitive dust will come from in-pit drilling and blasting, material handling (transport, storage, processing) and the tailings beach (DEIS Chapter 4.14-3). However, the impact analysis is minimal and inadequate.

We offer the following key comments related to "Sources of Fugitive Dust":

- Justification for soil density, percent silt, and threshold values of tailings particles as inputs in dust plume modeling is inadequate. Incomplete wind and precipitation data are applied in models.
- The volume of dust from the mine site is estimated but there is no analysis of whether, or under what conditions, Cu in dust would enter waterways where fish could be exposed.
- Information has not been pulled from RFIs into the DEIS in any meaningful way that would allow the reader to understand sources, volumes, and chemical make-up of dust.
- Critical data on soils classification, precipitation, wind speed are missing, outdated, or buried in RFIs and not summarized in the DEIS chapters.
- Assumptions about the efficiency of dust control are unrealistic. The DEIS and supporting record lack citations to published literature or analyses supporting the assumed effectiveness and feasibility of the dust abatement measures identified.

Adequacy of analysis of fugitive dust sources

Critical model data missing from DEIS

The following is a brief description of data missing in the DEIS for models of fugitive dust sources, deposition extent, and deposition rate. They are described in greater detail in other sections of the report.

- **Source chemistry.** In projecting future metal accumulation and concentration, the DEIS recognizes vehicles as the major source contributing to particulate matter (fugitive dust) but ignores the chemical contributions from the wear and tear of vehicles such as haul trucks. Similarly the DEIS ignores metals in mine material that may be toxic to aquatic life but not to human health, such as copper.

- **Deposition rates and metal concentrations.** The deposition rate of fugitive dust from the mine site, which informs the rate of metal accumulation in soils, is not provided in the DEIS but is provided in RFI 009. Deposition rates appear to be significantly lower than dust fall measured at industrial gravel roads in Alaska. The deposition rate should be expressed as a range, should consider the variability of source inputs, and should be based on dust fall rates at operating mines. The range of variability is missing in the DEIS and supporting documents. Particle density, a crucial value, is based only on "approved values for other Alaska mining projects" (RFI 009 pdf page 57), not actual measured values at Alaska mining projects.

- **Dust suppression.** The DEIS assumes that dust produced at the mine site will be suppressed entirely by watering. This is unrealistic. Chemical dust palliatives will likely be needed. This source contributing to dust chemistry is not recognized and the ecological impact of using this chemical component of dust is missing.

Inadequate assessment of soil types

There is no assessment of soil types at the mine site, except for a literature review using the Exploratory Soil Survey of Alaska (Reiger et al.1979) which, as the DEIS states, "is not sufficient for site-specific interpretations" (DEIS Chapter 3.14-2). A proper assessment relevant to assessing impacts of dust deposition would include soil chemical and physical properties. A table of very broad classifications is provided in Chapter 3.14, but the surficial geology map which shows the expected locations of glacial silt, bedrock, glacial till, all relevant to fugitive dust, is only in DEIS Chapter 3.13 Geology.

Recent soil survey information is available from the Natural Resources Conservation Service (NRCS 2016, updated 2018) (Figure 2). This information, more recent and more comprehensive than the ESS material, was not used in the DEIS. The NRCS 2016 contains detailed data soil physical properties, chemical properties, and soil erosion factors, as shown in this screenshot of the webpage for the Bristol Bay soil survey (Figure 3). Pebble DEIS authors should include this more recent information as part of their literature review and note how it influences impact assessments.

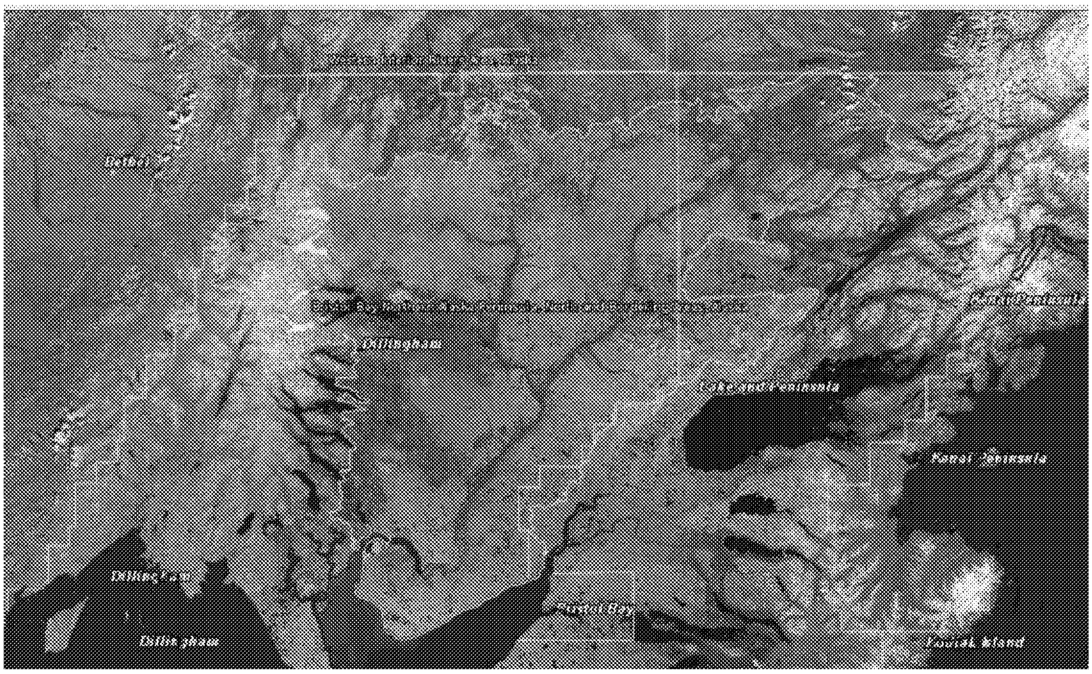

Figure 3. NRCS soil survey area. The NRCS conducted extensive soil sampling in the Bristol Bay area, with general sample boundaries shown by the yellow outline in the map. *Source: NRCS 2016*

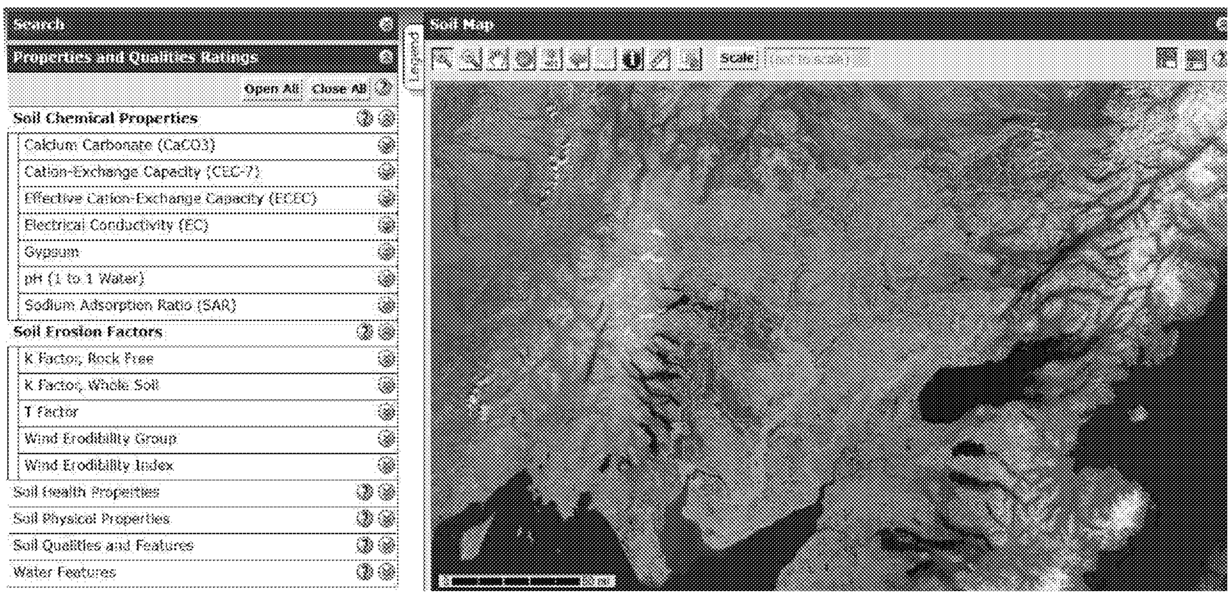

Figure 3. Soil chemical properties and NRCS soil survey map. The NRCS soil survey data is open to the public. A screenshot of the drop-down soil chemical properties and erosion factors is shown. *Source: https://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx*

Literature review is necessary but not complete in and of itself. PLP environmental baseline contractors should collect original soil type and chemistry data at the mine, ports, and road corridor sites likely to be impacted. Without this, there is no way to properly assess potential impacts in the DEIS, nor will it be possible to determine actual impacts from the mining project in the future.

It is useful to contrast the information presented in the Pebble DEIS and the Donlin DEIS (US Army Corps of Engineers 2015). Importantly, for the primary soil types listed in the Donlin DEIS, the slopes, drainage class, and qualitative assessments of susceptibility to wind or water erosion are listed (Donlin DEIS Table 3.2-1) (Figure 4). Their absence in the Pebble DEIS is a short-coming.

Information available in NRCS 2016 and possibly other sources could allow the Pebble DEIS to make assessments relevant to fugitive dust based on soil types, wind erodibility, specific slope angles where the soil type is found. Qualitative assessments, such as in the Donlin DEIS would be a start, but the data should also be utilized to generate more site-specific dust plume models, which in turn should be overlaid on aerial photos and ground-truthed mapping to best determine the type of vegetation, wetlands, and water bodies in the path of the plume.

Table 3.2-1: Mine Site Soil Types and Erosion Hazards

Soil Map Unit and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
R30FPA: Yukon-Kuskokwim Highlands, Boreal Floodplains and Terraces							
Boreal forest, gravelly floodplains and similar soils	Fluventic Haplocryepts	Loamy alluvium over sandy and gravelly alluvium	Toeslopes of floodplains on mountains	0 to 2	Moderately well drained; occasional flooding	Slight	Moderate
Boreal forest, loamy floodplains and similar soils	Aquic Cryofluvents	Coarse-loamy alluvium	Floodplains	0 to 5	Moderately well drained; occasional flooding	Slight	Moderate
Boreal scrub, gravelly floodplains and similar soils	Aquic Cryorthents	Sandy and gravelly alluvium	Floodplains	0 to 7	Somewhat poorly drained, occasional flooding	Slight	Moderate
Boreal scrub, silty terraces and similar soils	Typic Cryaquepts	Organic mat over silty alluvium and/or loess over gravelly alluvium	Terraces	0 to 5	Very poorly drained, no flooding	Slight	Slight
R30MTC: Yukon-Kuskokwim Highlands, Boreal and Subalpine Mountains							
Boreal forest, gravelly colluvial slopes and similar soils	Typic Haplocryods	Loamy colluvium and/or loess over gravelly colluvium	Backslopes of mountains, hills	12 to 110	Well drained; no flooding	Severe	Slight
Boreal scrub, silty colluvial slopes and similar soils	Histic Cryaquepts	Organic mat over loamy alluvium over sandy and silty alluvium	Backslopes, footslopes of mountains	0 to 1	Very poorly drained; no flooding	Slight	Slight
Subalpine woodland, gravelly colluvial slopes and similar soils	Typic Dystrocryepts	Gravelly colluvium	Summits, backslopes, shoulders of hills, mountains	5 to 46	Wells drained; no flooding	Moderate	Moderate
Boreal taiga, loamy colluvial slopes and similar soils	Typic Histoturbels	Organic mat over loamy cryoturbate over permanently frozen loamy slope alluvium	Footslopes, backslopes of mountains, hills	2 to 29	Poorly drained; no flooding	Severe	Slight

Notes:
Soil Map Units shown on Figure 3.2-1
Source: NRCS 2008.

Figure 4. Donlin mine soil erosion classifications. In addition to classifying soils for the Donlin Project, soils were assessed for susceptibility to wind and water erosion. *Source: Donlin DEIS Table 3.2-1*

Ore concentrate

Copper-gold ore concentrate will be loaded into 38-ton shipping containers at the mine site, transported by trucks along the road corridor, across Iliamna Lake on an ice-breaker ferry, by truck again to Amakdedori port, then unloaded onto lightering vessels and into the holds of bulk cargo ships in Cook Inlet.

Does ore concentrate contribute to the dust plume from the mine site? Ore concentrate dust was a significant source of dust at Red Dog until mitigation measures were adopted (Neitlich et al. 2017). Dust from ore concentrate would likely have a very high concentration of copper, will be dry,[2] and, with its small particle size similar to silt, would likely travel the furthest if not controlled (Walker and Everett 1987).

Although a dust plume map has been created for the mine site, the contribution of ore concentrate as part of the plume was not discussed in the DEIS. Sources used in air modeling suggest that ore concentrate was not considered in the "material handling" category (RFI 009 p8 and RFI 009 Appendix A Table 2), in the "wind erosion" category (RFI 009 Appendix A[3] Table 3), or as contributing to HAP metal accumulation (RFI 009 Table 1.3).

Possibly the ore concentrate will be loaded inside a covered area:

> *The upgraded copper-gold concentrate will be thickened to 55 percent solids by weight in a highrate thickener. The thickener overflow will return to various circuits for use as process water. The thickener underflow will be fed to a pressure filter to reduce the moisture to approximately eight percent. The filter product will be conveyed to specialized bulk cargo containers with removable locking lids that prevent dust emissions and incidental spills while maintaining product quality through the logistics chain.* (DEIS Appendix N Section 3.3.3.6)

Is this "conveyance" by conveyor belt to containers on a pad outside the mill? Is it all contained inside a building? Loading concentrate inside a building would mitigate emissions. This needs to be stated clearly, along with other mitigations if any, that affect the volume and chemistry of fugitive dust from the mine site.

Will ore concentrate contribute to dust at the port site? After lightering the 38-ton containers to the bulk carrier anchored offshore, the DEIS states that the shipping containers will be lowered into the hold before being tipped over to release concentrate into the hold. This – an entirely unorthodox approach and one that should be backed up with examples – is only made possible by the plan proposed in the DEIS to fill cargo holds no more than half-full.[4] This idea to send ships off only half-full seems a patently unrealistic economic choice. It is an important part of the analysis and should be described in the DEIS.

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[2] Concentrate will be dewatered and filtered to 8% moisture (DEIS Appendix N Section 3.3.3.6)

[3] This is in RFI 009 Appendix A "Pebble mine site modeled emission inventory". Another Appendix A is also listed in RFI 009 as "Pebble mine site construction modeled emission inventory".

[4] The information on filling ships no more than half full is provided in RFI 007 p5 and RFI 009 p14 but not in the DEIS.

> *Copper-gold concentrate would be transported from the mine site to Amakdedori port by truck and ferry in covered bulk cargo containers and stored between vessel sailings on a dedicated laydown pad adjacent to the jetty.... above. The containers would be lifted by crane into the open hold of the receiving ship. Once inside the hold, the container lid would be opened, and the container turned upside down to unload the concentrate into the ship's hold.* (DEIS Chapter 2-69,5 DEIS Figure 2-40, DEIS Figure 2-52)

Port activities will be different for the Alternative to transport copper-gold concentrate by pipeline.

> *Concentrate would be dewatered and stored at the port site, and the dewatered concentrate would be stored in a large storage building until the lightering system would be used to load the concentrate onto bulk carriers for transport. The lightering system would use bulk handling of the concentrate to load the bulk carriers, with controls to reduce dust emissions (e.g., **covered conveyors**) (PLP 2018-RFI 066). Because the material would be stored inside, impacts to surface water hydrology are not expected.* (DEIS Chapter 4.16-39)

For this Alternative there would not be a dry concentrate susceptible to wind erosion at the mine site, since the concentrate would be dewatered at the port. However, the concentrate pipeline Alternative replaces the mitigation action of lowering shipping containers into the hold of the bulk carrier with the more traditional covered conveyor belt system to load concentrate, which is likely to release considerably more dust.

The impacts of Alternatives cannot be compared when different dewatering, storage, and load-out systems are proposed, with no discussion of the effectiveness or practicality of the options and no discussion of the difference in impacts from fugitive dust.

Geographic extent of dust deposition

Mobilization and deposition distance of dust varies with material density, size, wind speeds and terrain, as well as with the activity and travel speeds of heavy trucks hauling supplies, waste rock, ore, and concentrate (Countess et al. 2001, Cecala et al. 2012). Additionally, areas with road networks with dust originating from many sources spread more dust than individual sources (Walker and Everett 1987). The dust dispersion model likely does not fully account for these variables, and in so doing may underestimate the area impacted. All these factors need to be accounted for in an updated model.

<u>Modeled dust plume and areas impacted</u>

Maps need to be provided to show the expected area within which vegetation, wetlands, and waters will be impacted. Specifically, maps need to show how a 100 m zone was applied around mine sources:

> *Therefore, a potential indirect impact area was calculated using a 330-foot (100 m) zone on all direct disturbance footprints* (DEIS Chapter 4.22-12)

The choice of a 100 m zone should be reconsidered and justified. In the Pebble Project DEIS, the 100 m zone was the sole source relied on to calculate the area of vegetation, wetlands, and water bodies impacted by dust, and is different from the dust plume map shown in Chapter 4.14. A reference that is provided with respect to the fugitive dust area is inaccurate (as RFI 065 refers to the summer ferry, not fugitive dust): *In terms of impact extent, the modeled areal extent of dust deposition in construction and operation phases of the mine site is depicted in PLP 2018-RFI 065* (DEIS Chapter 4.18-11)

Studies have shown that while dust load decreases with distance, it can be noticeable up to and likely beyond 600 m to 1,000 m (0.4 to 6 miles) (Walker and Everett 1987, Myers-Smith et al. 2006).

The Pebble Project DEIS appears to acknowledge a much more extensive deposition zone than 100 m (Figure 5), but whether all water bodies within the plume shown in the figure were included in the listed acres of wetlands, ponds, and streams is not clear, as there are no maps to convey the information.

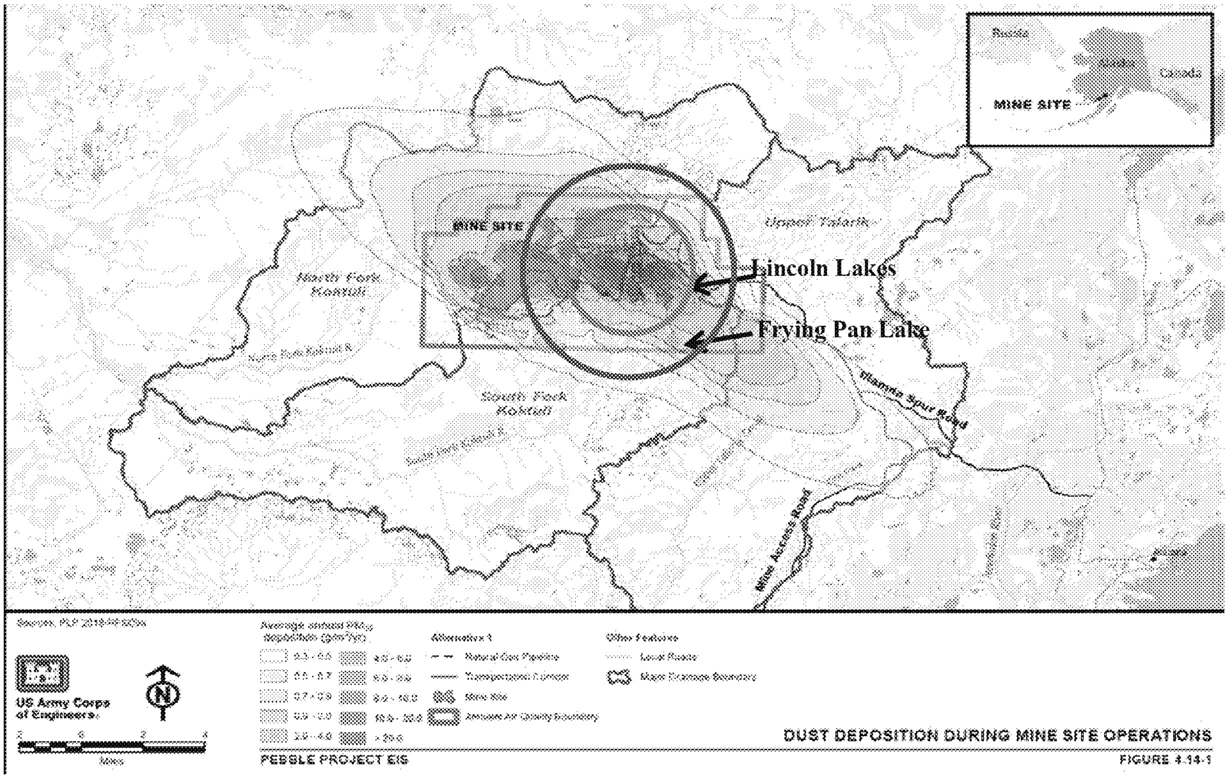


Figure 5. Mine site fugitive dust deposition plume. Concentric rings with diameters of 2 and 4 miles have been added to the figure. Frying Pan Lake, over 2 miles from the main mine area, and Lincoln Lakes located over the eastern portion of the ore deposit, are in the path of modeled dust deposition. These estimated deposition rates appear low relative to measured rates on dirt or gravel roads in Alaska. *Source: modified from DEIS Figure 4.14-1*

<u>Particle density</u>

The lighter the particle, the further it will travel and the greater the geographical area impacted. In a study of an industrial gravel road in Alaska, although 97% of dust settled within the first 125 m, silt could travel much further:

> *[The dust deposition zone from] 30 m to > 1000 m, [received] deposition of 0.6 to 0.02 kg/ha/d, 85 to 90% silt- and clay-sized material with 40 to 50% fine silt and clay with very large reaction surfaces and electrostatic properties* (Walker and Everett 1987)

For fugitive dust plume modeling in the Pebble Project DEIS, a single particle density was chosen despite the fact that density will vary with source material. Ore concentrate, which may have density similar to silt, does not appear to have been included in the modeling. This information is only found in an RFI (RFI 009) but should have been included as part of the analysis in the DEIS chapter on soils because it affects the distance particles can travel and therefore the total area impacted.

The particle density chosen was 2.65 g/cm3. This is the same density chosen for modeling the dust plume at the Donlin mine, and the value was challenged by one of the contractors (Cardno 2015). There is on-site particulate data (PM10 and PM2.5) from at least January 2009-December 2012. This can be used as a baseline against which to measure dust volume and size when the mine is in operation.

Wind speed and precipitation

Wind speed influences dust deposition. It appears that the Pebble DEIS relied on meteorological data collected January 2009-December 2011 (RFI 009 p8 and RFI 009a Follow up questions), but on-site data were collected January 2005- December 2012 by Hoefler and SLR (who purchased Hoefler in 2010) (SLR 2013). This decision is not justified in the DEIS. There are wind data for at least 2008-2012, although the amount of data varies between the eight meteorological stations on site. The full dataset should be used to model dust deposition. The DEIS states that "*Annual fugitive particulate matter (PM) emissions were calculated based on conservative scenarios that assumed worst-case conditions for each activity or source component, such as peak ore crushing capacity, maximum ore hauling distance from final pit, and maximum waste rock hauling*", but makes no mention of wind speed in this section (Chapter 4.14.2.1). Therefore, how can the reader be assured that "worst case" wind speed was applied to the model?

The dust plume figure (DEIS Figure 4.14-1 shown in Figure 5 of this memo) should include the locations of all the meteorological stations, and, if data from only some stations is used, identify those on the figure. It should describe the range of wind speeds observed at the different stations and how those were applied in determining the dust plume deposition zone.

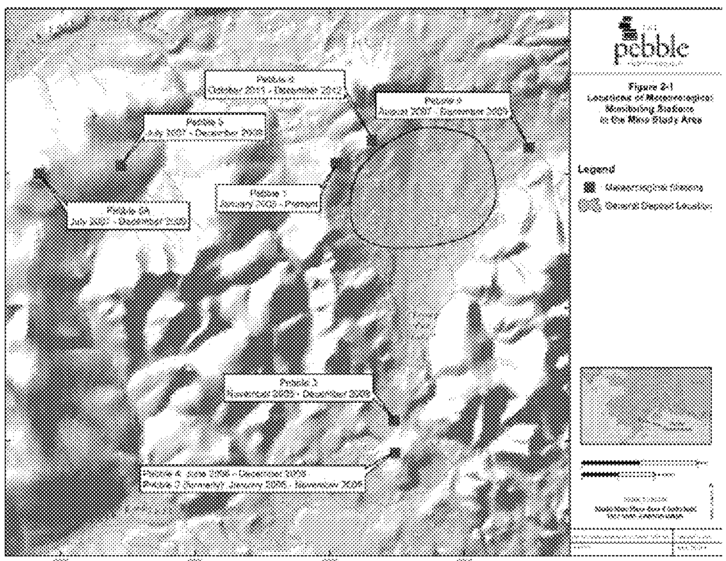


Figure 6. Pebble Project meteorological stations.

The DEIS states that 259 days of the year have an average of 0.01 inches of precipitation or more, with 93 of those occurring between June – September. This appears to be based on a single meteorological station (Pebble 1) although there are eight meteorological stations at the site (Figure 6).

The average number of days with precipitation could currently be much smaller, closer to 120-150 days (AP-42 2006, Figure 13.2.2-1). This may increase during mine life with climate change, but precipitation increases are expected to occur with higher intensity, which could increase hydrologic erosion.

Dust control

The DEIS states

> *Soils capable of retaining moisture in the project area are generally considered to have a low susceptibility to wind erosion, due to inherent moisture content from periodic precipitation or snowmelt throughout the year. For this reason, the potential for wind erosion would be greatest during drier periods lasting 1 to 2 months during the summer. If necessary, wind erosion can be mitigated through dust-control watering as needed during the summer.* (DEIS Chapter 4.14)

Dust control measures are commonly taken to reduce immediate health hazards to workers[5] and to reduce impairment of visibility that can cause traffic accidents (Cecala et al. 2012). Because abatement measures are imperfect, background fugitive dust remains a source for environmental contamination, especially where mining and transport operations are continuously or frequently occurring over time periods of many years, which will occur at the Pebble mine.

Source control

The only mitigation mentioned in the DEIS consists of:

> *Using BMPs, such as revegetation planning, watering, and using dust suppressants to control fugitive dust* (DEIS p5-4)
>
> *Control measures could include speed limits, use of approved chemical dust suppressants, and application of water*….. Use of closed containers to transport concentrate (DEIS Table 5-2)

These actions are unlikely to reduce dust from some sources (e.g. drilling and blasting, material handling). Also the DEIS does not describe whether loading concentrate at the mine site would occur inside a closed building. This would be a mitigation and should be stated, along with any additional mitigation measures that reduce load-out dust (Cecala et al. 2012).

Watering

The statement that watering will control dust runs counter to evidence in Alaska and at mine sites. "Watering" is certainly not sufficient at the Red Dog Mine; they noted "conventional dust control" does not work for four months out of the year due to low humidity and freezing (Teck 2005); in 2014 they purchased a guar gum based suppressant for tailings beaches and were testing three more products (Teck 2015).

The model in the DEIS applies a control efficiency of 80% to dust suppression for fugitive dust (RFI 007). This number comes from the federal AP-42 manual. This manual also notes that

---

[5] While not necessarily relevant to fugitive dust, we would question the model input for baghouses in unheated operations, which is set to 0° Kelvin, or -460°F (RFI 009 p2). This is unrealistic.

> *Control techniques for fugitive dust sources generally involve watering, chemical stabilization, or reduction of surface wind speed with windbreaks or source enclosures. Watering, the most common and, generally, least expensive method, provides only temporary dust control. The use of chemicals to treat exposed surfaces provides longer dust suppression, but may be costly* (AP-42 2006 Section 13.2.2).

While the AP-42 does apply an 80% control efficiency, this degree of efficiency is applied to unpaved roads with chemical dust suppression (AP-42 1998, Chapter 2) while the Pebble Project does not anticipate applying chemical dust suppressants. The Pebble Project intends to use water only for dust suppression. In the AP-42, control efficiency for watering – in an area where winds remained below 22 mph – was 40-70% for PM10 and 30-60% for total suspended particulates, and in a test study under which a section of unpaved road was watered for 30 minutes, watering was about 72% effective for the next 3-4 hours (AP-42 1998, Chapter 4). This suggests that watering would be less effective than assumed in the DEIS equations, more dust would result, and therefore potentially the concentration of trace elements deposited on the land and water would be greater. Additionally, the AP-42 water control efficiency is for conditions with winds below 22 mph; sustained wind speeds at the Pebble Project are frequently greater than 25 mph (RFI 009 p3), further decreasing the real-world efficiency of watering.

Chemical dust palliatives will almost certainly be needed. If salts, such as $CaCl_2$, are applied, they can become incorporated into fugitive dust as they dry (Stehn and Roland 2018). As this material settles on acidic tundra vegetation, it can change the pH and, through that, abundance and diversity (Walker and Everett 1987, Myers-Smith et al. 2006). The ecological impact of using this chemical component of dust is missing.

Available resources

Dust control requires dedicated water trucks and dedicated personnel. The experience at the Highland Valley Copper Mine in British Columbia is that the water truck, when it breaks down, is the last in line at the mechanics shop – maintenance and repair of ore-hauling trucks and other machinery is prioritized. This means that weeks can go by with no watering at all at the mine site (personal communication, Jeff Jewel, United Steelworkers Union).

Dust seasons

The DEIS may incorrectly assume that the most dust will be generated in the summer. In a study of road dust at Prudhoe Bay, near-road volumes of dust were greater in summer, but 1,000 m from the road winter dust accumulated at ten times the rate of near-road dust. These distant areas would primarily receive small particulates. This suggests that at the mine site, the ore concentrate and other fine material could travel furthest in winter.

It is during summer when humidity is higher and mitigation (dust suppression) may be achieved through watering at the mine site and roads. However, at Red Dog Mine, while August and September were the windiest months, the most extreme winds were associated with winter storms (Neitlich et al. 2017). Also the worst dust at the Red Dog Mine has been in the winter when humidity is lower and "conventional dust control" methods cannot be applied:

During the winter months (October – April), the site experiences extremely low specific humidity. There are four months (December – March) that average below 1 gram of water per kilogram of air. During this period, conventional dust control and application methods cannot be used do to the freezing conditions and low specific humidity (i.e. road watering or hygroscopic palliatives).

....The monitoring indicates a cyclical pattern in TSP [total suspended particulate] concentration with highest concentrations in the winter months and lowest concentrations in the summer months. (Teck 2005)

Experience at Red Dog Mine and generally in Alaska suggests dust deposition may be greatest in winter, due to high winds, low humidity, and limited options for suppressing dust. This indicates that the assumption of maximum dust generation during the summer at Pebble needs to be revised. It reinforces the need to know how wind speeds were used in determining the extent of the dust deposition zone.

Impacts of fugitive dust

The environmental consequences from physical (turbidity) and chemical (toxicological) effects of dust once it enters freshwater ecosystems are not fully addressed in the DEIS.

- Fugitive dust chemistry as reported in the DEIS does not include Cu as a component, therefore environmental consequences to aquatic life are severely underestimated. There is no analysis of the concentrations of Cu that will leach from dust deposited on different parts of the landscape.
- Dust deposition rates appear to be vastly underestimated, and this affects the projected accumulation of trace elements in the environment.
- There is very minimal soil and sediment baseline chemistry where mine facilities will be placed, and many water bodies in the path of fugitive dust have not had baseline sampling. Without this baseline information, there can be no quantitative measurements to assess whether mine-related metals accumulate in the environment, limiting ecological impacts analysis.
- There is no ecological analysis that considers the connected physical and chemical effects of fugitive dust on the environment or the resulting potential impacts on birds, mammals, fish, or aquatic resources.
- There is no analysis of physical or chemical impacts to wetlands or water bodies, only the number of acres directly impacted, therefore the impacts of Alternatives cannot be assessed.
- There is no description of wetlands and water bodies within the likely deposition zones or of how they support aquatic life, therefore the impact of dust settling on them cannot be assessed.
- There is no data on the ability of metals in dust to leach in different environments (e.g. slightly acidic wetlands, neutral-pH ponds, gravel stream banks).

Baseline sampling locations

Baseline soil chemistry sampling was conducted at 117 locations, but there is no map or list of their locations in DEIS Chapters 3.14, 4.14, or Appendix K3.14, therefore there is no way to determine if they were representative either geographically or with respect to soil type. It appears that the sites, as shown in the Environmental Baseline Document (EBD), are scattered throughout the general area and only five to eight are actually at the mine site (SLR et al. 2011) (Figure 7). A GIS document is available, but it is not a file that most of the public can open (RFI 050).

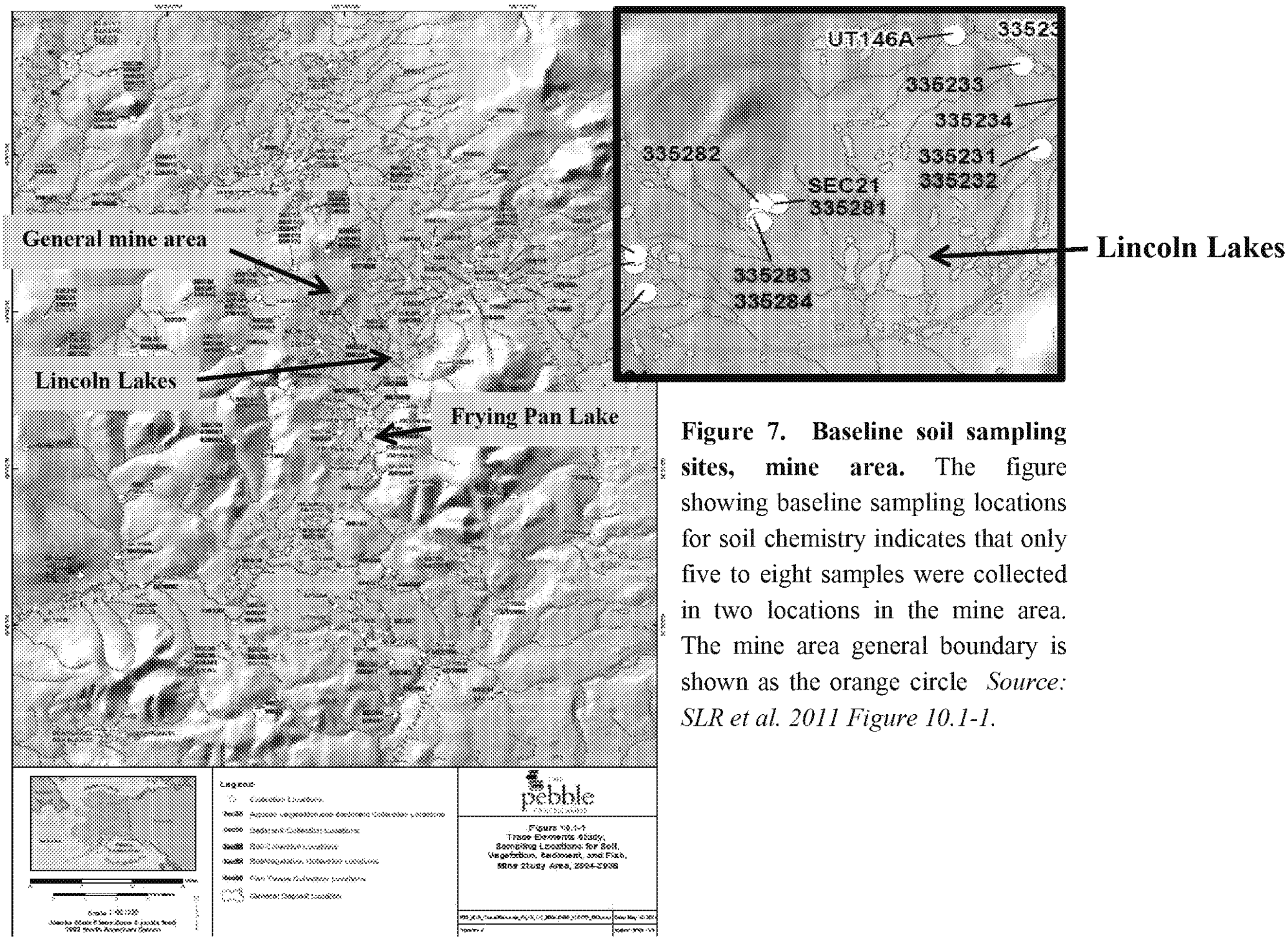
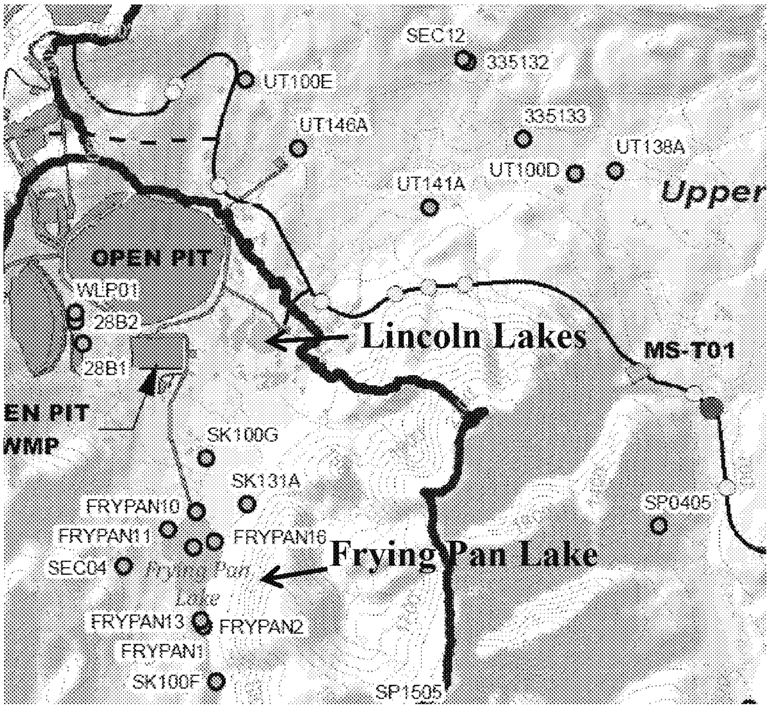


Figure 7. Baseline soil sampling sites, mine area. The figure showing baseline sampling locations for soil chemistry indicates that only five to eight samples were collected in two locations in the mine area. The mine area general boundary is shown as the orange circle *Source: SLR et al. 2011 Figure 10.1-1.*

Sediment and water quality sampling is more comprehensive, but misses the Lincoln Lakes and several lakes and ponds that would be in the path of the fugitive dust plume, including areas near the proposed mine facilities that would be most heavily impacted (Figure 8). As the mine expands to the 78-year alternative, these water bodies will very likely be even more heavily impacted.

In addition to the NRCS (2016) data mentioned earlier, soil, sediment, and rock chemistry data collected by the USGS are publically available and should be included in the baseline (Granitto et al. 2011, USGS 2019). This does not release PLP from the obligation to collect enough baseline data to determine future impacts at the mine site and mine infrastructure. Without baseline soil, sediment, and water chemistry from sites in the path of the fugitive dust plume, the potential environmental impact cannot be assessed in the DEIS or in future monitoring.



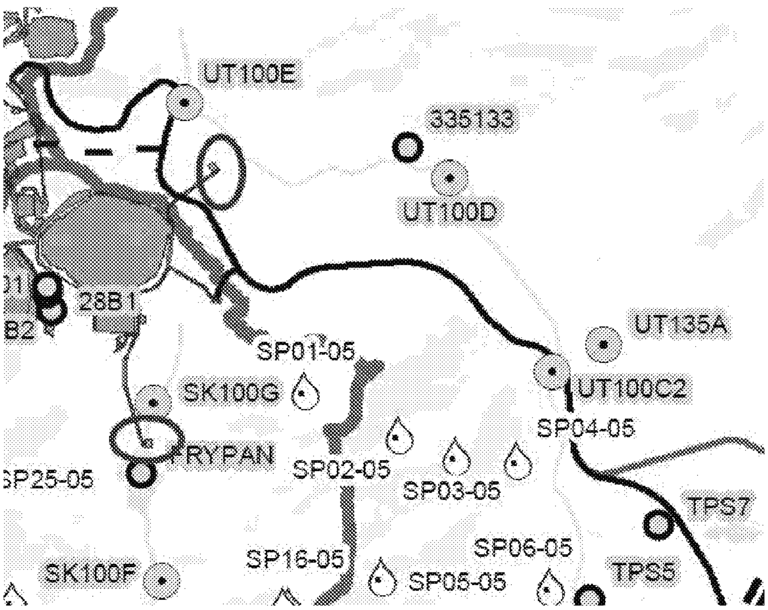


Figure 8. Baseline sediment and water quality sampling sites, mine area. Several ponds, streams, and wetland sites were sampled for baseline trace element chemistry (SLR et al. 2011). However, Lincoln Lakes and ponds around them that are in the path of fugitive dust have not been sampled. Only part of the area the plume will impact is shown; a similar area to the northwest will also be impacted.

(Upper) The map shows sediment sample sites (DEIS Figure 3.18-3). There are many water bodies southwest of the pit that have no sediment samples.

(Lower) The map shows water quality sampling sites (DEIS Figure 3.18-1). Streams are shown in orange circles, lakes and ponds in blue circles, and groundwater seeps in green water drop symbols. The map does not show the many water bodies in the area. Notably, sediment sites SK131A and UT146A shown in the sediment sampling map are not shown in the water quality map; these are locations that will receive water treatment discharge. Several sites that have baseline water quality data (e.g. UT141A, SK133A, SK136A) (Schlumberger et al. 2011) are not shown on the maps provided in Chapter 3.18 (Affected Environment, Water-Sediment Quality)

Sources: Maps are from DEIS Figure 3.18-1, DEIS Figure 3.18-3. Information in textbox is from Schlumberger et al. 2011, SLR et al. 2011, and ERM 2018.

Adequacy of analysis of fugitive dust chemistry

The DEIS should clearly state the sources used in metal accumulation calculations, the trace elements that come from each source, and should estimate the concentrations accumulated over 20-year and 78-year mine life for all contaminants that are both present in source material and toxic to aquatic life, birds, wood frogs, or other potential receptors. This would need to include Cu and Zn.

<u>Chemical components from mine material</u>

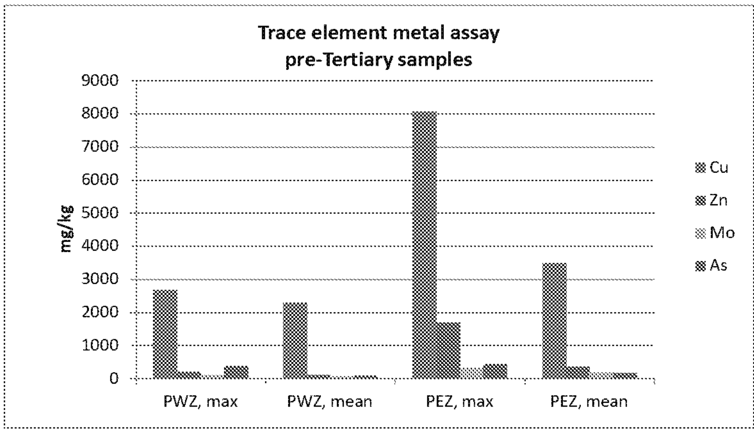
Dust originating from the mine site will contain leachable metals that could impact plants, animals and aquatic resources. The most problematic and blatant problem with the DEIS dust assessment is the complete omission of analysis of Cu, which is toxic to aquatic life in small concentrations, in fugitive dust. Indeed, there is no recognition that Cu will be a component of fugitive dust.

It is certain that the target ore will be a component of fugitive dust, but the DEIS only analyzes the potential concentrations of metals designated as Hazardous Air Pollutants (HAPs): Sb, As, Be Cd, Co, Cr, Hg, Mn, Ni, Pb, and Se (DEIS Table 4.14-1). Bulk chemistry of waste rock can be used to provide a rough estimate of the relative importance of Cu (Table 1). Table 1 shows that Cu and Mn are the first- or second-most dominant metal. When the DEIS estimated the concentration of HAPs, Mn had the heaviest deposition -- one to two orders of magnitude greater than the 20-year incremental increase of other metals (DEIS Table 4.14-1). This clearly indicates that Cu, found in waste rock at similar concentrations to Mn, will be a dominant component of fugitive dust from the mine site. It needs to be accounted in the assessment of impacts.

Table 1. PWZ Bulk Metal Concentrations in Pre-Tertiary and Tertiary Waste Rock. *Source: PLP 2018*

	As	Cd	Co	Cr	Cu	Mn	Ni	Pb	Se
Pre-Tertiary (mg/kg)									
Mean	98	0.65	23	111	241	399	25	18	10
Max	913	2.84	39	217	7540	1640	51	120	23
Tertiary (mg/kg)									
Mean	26	0.19	23	66	108	972	21	8	1
Max	102	0.42	30	121	1075	1495	39	20	11

Metal assay testing also confirms that Cu is the primary trace metal in pre-Tertiary rock (PLP 2018 Table 11-10) and tailings (PLP 2018 Table 11-30) (Figure 9). Metal assays for Tertiary samples were not available. Thus, omitting Cu from the analysis of dust is unjustifiable and needs to be remedied in the Revised DEIS.



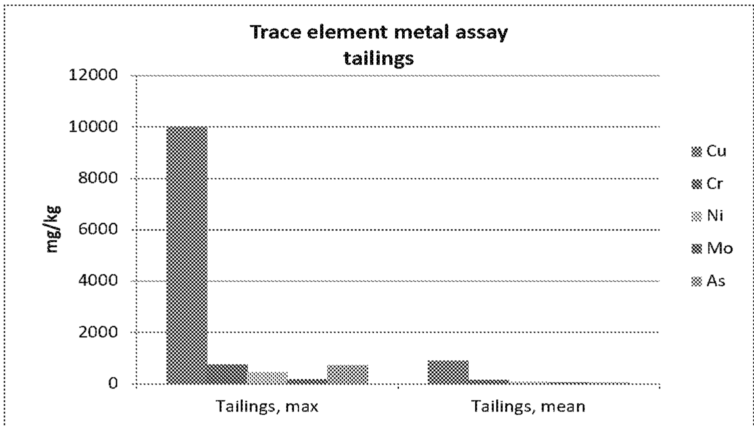


Figure 9. Trace metal analysis of pre-Tertiary samples and tailings. Copper has the highest concentration of all the trace metals in analysis of pre-Tertiary samples and tailings. Only the trace metals with the highest concentrations are shown. PWZ = Pebble West Zone, PEZ = Pebble East Zone. *Source: Adapted from PLP 2018, Tables 11-10 and 11-30.*

Chemical components from vehicles

The majority of fugitive emissions from the mine site will be from vehicle traffic (Table 2). Vehicles release metals from haul truck brakes (Cu, Ni) and truck tires (Cd, Zn) which can become entrained in dust (Pratt and Lottermoser 2006). They can also release hydrocarbons. The DEIS ignores vehicle contributions as components of dust chemistry and performs no assessment at all of the contributions of Cu and Zn, which are toxic to aquatic life.

Table 2. Sources of mine site fugitive dust. Units are in tons per year. *Source: RFI 007 Appendix A-3 Table 1b*

Source	Total potential PM emissions	Total potential PM10 emissions	Total potential PM2.5 emissions
Vehicle traffic	5,977	1,461	146
Wind erosion	1,021	511	77
Material handling	822	389	59
Bulldozing	217	163	23
Grading	147	88	5
Blasting and drilling	123	64	4
Crushing	10	10	10

The DEIS also ignores components from salts that may entrain in dust if chemical dust palliatives are needed to control dust in the mine area and on the tailings beach.

Volume and deposition rate

Dust volume

RFI 007 has information on volumes of dust. For example, fugitive "emission units" as particulate matter is expected to be over 8,300 tons per year (tpy) from the mine site (Table 1.1, page 3 of RFI 007). Analysis of the increases in metal concentrations in soil is provided in the DEIS, but the actual volume should also be noted; no dust volumes are mentioned in DEIS Chapter 4.14 (Soils, Environmental Consequences). The volume, along with deposition rate, provides information on the mass of particulates entering the environment per area of land or water. Particulates alone can cause damage (e.g. turbidity in waters, smother vegetation, respiratory issues).

Deposition rates

The deposition rate is a critical component of determining the mass of metals that accumulate in soil or sediment over time. It provides the rate at which particulate matter accumulates. When combined with the concentration of metals and contaminants entrained in dust, it allows for the rate of contaminant accumulation to be calculated.

Chapter 4.14 does not explain how the deposition rate was determined. A figure in the DEIS describes fugitive dust deposition up to >20 g/m^{2-}yr at the mine site and up to 4 g/m^2-yr within 4 miles downwind in the dust plume (Figure 5). These yearly rates are roughly within the **daily** rates observed at Prudhoe Bay roads:

> *....average dust deposition rates were 30 to 250 g/m^2-d within 100 m from the road and 0.8 to 13 g/m^2-d from 100 to 1000 m from the road* (Walker and Everett 1987)

Unless there is a reason why the particle density would be much greater at the Pebble Project, or the wind speeds much lower, it would seem that the deposition rate estimated for fugitive dust, and metal accumulation, during mining operations may be vastly underestimated. This large difference from observations on other roads must be explained in a Revised DEIS.

Deposition rates will decrease with distance (Figure 5), but only a single deposition rate was applied to the calculations of particle deposition and resulting metal accumulations. The deposition rate of 0.056 g/m^2-d and 2.05 g/m^2-yr was applied when determining the accumulation of metals in soil (RFI 009 Table 1.3), and may severely underestimate the actual rate of dust fall and resulting accumulation of metals. Even if the daily rate were accurate, a simple calculation of the daily rate times 365 days per year results in 20.4 g/m^2-yr, not 2.05 g/m^2-yr. This needs to be explained in a Revised DEIS.

Independent reviewers should review the inputs to the deposition rate model and base the rate estimates on dust fall collection at actual mining operations, such as Red Dog. Revised estimates, and the changes to metals concentrations that would result, should be provided in a Revised DEIS.

The assumption of the deposition rate of fugitive dust used in the DEIS for the mine site may reasonably be questioned. The rate of dust settling, in combination with the concentration of metals in fugitive dust, determines the mass "load" of metals entering the environment.

Contaminant accumulation

Once particulate deposition rate is estimated, metal and salt accumulation can be calculated. The DEIS soils chapter provides only an equation, for estimating the concentration of metals that will accumulate in soils due to dust (Cs) (DEIS Chapter 4.14.2.1).

$$Cs = 100t_D * \left(\frac{D}{Z_S * B_D}\right)$$

Chapter 4.14.2.1 assumes values for Z_S (soil mixing zone depth) as a constant one inch and t_D (time length of deposition) at 20 years. B_D (soil density) is a constant 2.65 g/cm^3, a value found in RFI 009a and chosen because it was “approved for other mine sites”, and D is the deposition rate of 2.05 g/m^2-yr found in RFI 009 Table 1.3. The calculated concentration of metals in soil as baseline and after 20 years of mining are provided in the DEIS (DEIS Table 4.14-1). The concentration of metals in soil for accumulation over the 78-year “expanded alternative” was not provided. Of the inputs to the equation, we have questioned both the choice of the soil density (also see Cardno 2015) and the choice of the deposition rate. If these change, the concentration of metals accumulating in soil and water will also change. We have also questioned the baseline, which, in the mine area, appears to consist of a small cluster of sites southwest of the mine. If this changes, the total concentration in soil and/or the percent increase over a 20- or 78-year mine life will change.

The variability in input values for dust sources such as ore stockpiles, blasting, tailings beaches, and other mine sources should be discussed explicitly as part of the analysis in the DEIS and not be buried in an RFI. This is important because some inputs may be known to have significant variability, and how that was incorporated may impact the final results.

Contaminant transfer to the environment

Particulate matter itself will have consequences, and the fate and effects of components within dust must also be addressed to adequately assess the project’s environmental consequences. Despite the fact that environmental contamination by fugitive dust measured at any given time might appear small, because of the very long time frame over which the project is proposed to operate toxics such as trace elements may form a growing pool of contaminants within the organic soil horizons or in pond sediment and may further disperse and affect connected water bodies and their biota.

Runoff

Runoff was considered by the DEIS to be a minor source of contamination from fugitive dust and not worth analysis (Appendix K4.18.3). No studies or direct measurement was provided to back up this decision, other than a statement that runoff would be absorbed by vegetation. However, dust is mobilized in two ways: through wind and through water. Runoff from the mine site is intended to be captured and treated, but dust that is transported off-site by wind and settles on land or vegetation will be able to mobilize again through both wind and water.

Salts can become entrained in dry dust and transported; from there they are easily leached out with rain (Kravitz and Blair 2019). Other runoff-related issues not considered are the potential for dust to settle on stream banks and be washed in, contributing to turbidity and sediment smothering benthic fauna or clogging interstitial gravel. Additionally the following statement was made based on the calculated projection that fugitive dust would make only very small changes to soil metal concentrations:

> *Furthermore, baseline metals concentrations in soil and sediment are similar; therefore, any soil particles washing off into the waterbody would not likely introduce higher metals concentrations than are already present in the waterbody (i.e., mixing of similar concentrations would result in similar concentrations).* (DEIS Appendix K4.18.3.1)

This may not be correct, given our observations that dust deposition rates may be underestimated and that elements such as Cu and Zn were not assessed, and ignores potential contributions from salts.

This also ignores a linked chemical-physical process. If metal sulfides are entrained in dust and settle on areas such as a streambank or road bank, they will oxidize and leach Cu and potentially other metals. Both the dust particles and leached metals may then be further transported by runoff from road watering, rain, or snow.

Direct deposition on water bodies

The DEIS provides an estimate of trace elements from fugitive dust entering water bodies, with analysis of the change in sediment and surface water quality. However, there is no analysis of the expected changes in turbidity. This is an important impact to water bodies, particularly the numerous small ponds close to the mine site. As noted in the section on baseline, there are many water bodies that are very close to the mine site and would be in the path of fugitive dust that have no baseline information.

Although the figure of the fugitive dust plume indicates that concentrations of particulates will decrease with distance from the mine, it does not appear that this was taken into account when impact analyses were conducted. Instead, the single deposition rate of 2.05 $g/m^2/y$ was used for both soil and sediment, and to calculate the added concentrations to surface water they developed a relationship between surface water and sediment from baseline data (DEIS Appendix K4.18.3.2). This may severely underestimate deposition rates and metals in some locations and potentially overestimate in others.

Trace element leaching

The DEIS assumes that all metals in mine site fugitive dust will leach when deposited on water bodies, and all will enter sediment (DEIS Appendix K4.18.3.2). This is a conservative transfer of metals from dust particle to water or sediment, but only considers the 11 HAP metals (DEIS Chapter 4.18-16, Table K4.18-18).

The ore at the Pebble Project contains chalcopyrite ($CuFeS_2$), covelite (CuS), and some digenite (Cu_9S_5) and bornite (Cu_5FeS_4) – which are all copper sulfides (SRK 2011 Tables 11-17 and 11-18). These minerals will be present in dust originating from drilling, blasting, ore stockpiles, ore concentrate, and to some extent in tailings. As sulfides, they will oxidize when exposed to air. When dust settles on vegetation, wetlands, and streambanks, it will be subject to wetting and drying cycles. This will drive oxidation and subsequent formation of acid and release of Cu.

The DEIS recognizes that fugitive dust will leach metals to groundwater. Because groundwater is highly connected to surface water in the Pebble Project area, there is also a risk of toxic metals migrating from groundwater to surface water. This was not discussed in the DEIS. Nor was accumulation of trace elements on soil with leaching to groundwater or surface water for the 78-year mine alternative discussed. A Revised DEIS must analyze ecotoxic trace elements common in ore which will leach at the onset of oxidation as acid etches into the rock matrix.

Geochemical Humidity Cell Tests estimate the rate at which minerals will leach from material, simulating wetting and drying cycles similar to what dust will be exposed to on the landscape. This testing confirms that Cu will leach from pre-Tertiary rock, from tailings, and, although at a lower rate, from Tertiary waste rock (Figure 10) – and suggests that Cu will leach from dust onto the underlying land and water bodies.

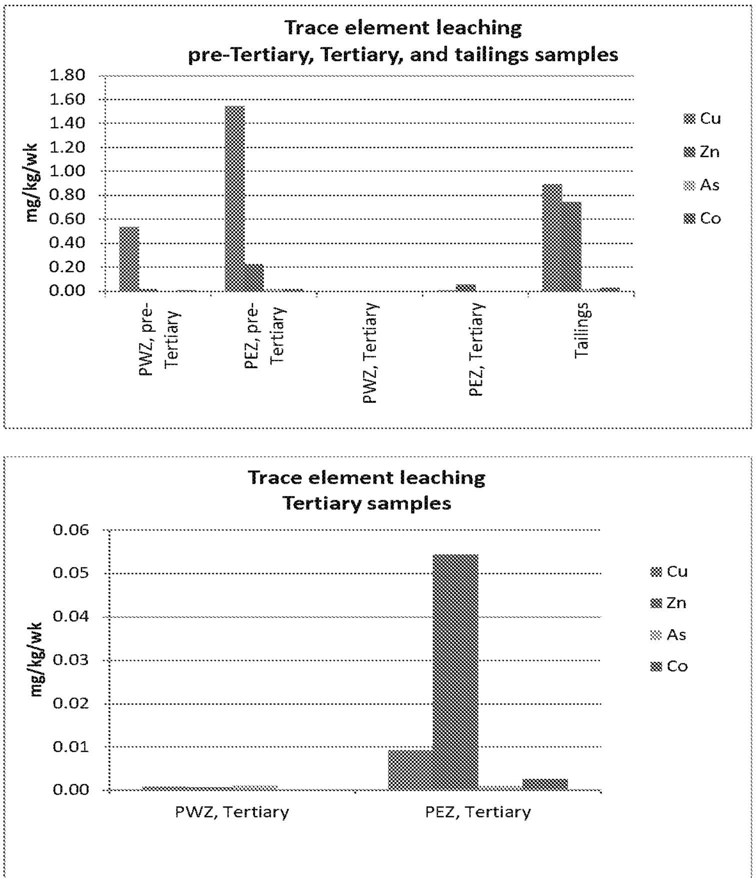


Figure 10. Leachate from mine material. (Top) Trace element leaching based on Humidity Cell Tests conducted on pre-Tertiary and Tertiary rock samples, and tailings. Copper is the dominant material that leaches from pre-Tertiary and tailings material. (Bottom) This chart shows only the Tertiary samples (same data as for the top chart). While Tertiary samples leach at a lower rate, copper and zinc are the dominant trace metals that leach. PWZ = Pebble West Zone, PEZ = Pebble East Zone. *Source: Adapted from PLP 2018, Tables 11-12, 11-17, and 11-33.*

However, if fugitive dust enters areas with high loads of dissolved organic carbon (DOC), trace metals that leach may bind to DOC and be less toxic to aquatic life. Dust that enters small ephemeral ponds, of which there are many in the area, may cause temporary turbidity and block photosynthesis, then sink to the bottom and oxidize in the summer when the pond dries up. If this occurs, in dry and windy conditions the pond sediment may re-mobilize, now carrying with it the fugitive mine site dust that is oxidizing. Dust that enters permanent ponds may only experience turbidity without Cu leaching; the extent to which other components leach will depend on the pH conditions, DOC, and other factors.

Landscapes are dynamic. Dust will accumulate in some locations over winter and be released at snowmelt, with its Cu load, into the underlying environment. Dust can re-suspend from ephemeral ponds and mobilize in summer. Streams and groundwater tables will rise and fall. Vegetation dies off or increases. Trace elements can sorb, precipitate, and remobilize with influences of UV light, pH, Fe, DOC, and bioturbation of benthic invertebrates in sediment. Some metals and metal species will be more mobile than others; for example, Zn in deposited dust may be more mobile in water than Pb (Teck 2005).

While the entire ecosystem cannot be modeled, the factors that impact contaminant movement need to be recognized and monitored. Some contaminant impacts can be better modeled than they have been in the DEIS, for example the impact of releasing a winter build-up of Cu suddenly into the underlying environment. For the mine site and associated infrastructure, the fate and transport needs to be assessed based on the expected chemical make-up of fugitive dust and the type of landscape it enters. The impacts are expected to overlap with other impacts from dewatering and habitat fragmentation.

Sequestration, dilution, accumulation, and transformation of elements will be different depending on the environment they enter: wetland, oxygenated stream, still pool, rocky hillside, freshwater lake. These affect how bioavailable a trace element will become. Bioaccessibility, trophic transfer, and bioaccumulation then determine the impacts through the food chain.

Impacts to vegetation

Fugitive dust from the mine site is estimated to impact nearly 900 acres of wetlands, 46 acres of lakes and ponds, and 10 acres of rivers and streams (DEIS Chapter 4.22). An additional 3,000 acres of vegetation would be impacted by the mine site dust (DEIS Chapter 4.26). Much of this area would receive repeated inputs of thousands of tons of dust annually (RFI 007), and some will overlap with fugitive dust from the road system. While nearly 4,000 acres of impacts is not trivial, a simple list of the acres and broad categories of landscapes impacted is insufficient for an analysis of environmental consequences.

Terrestrial vegetation

Dust may accumulate over many years on vegetation, blocking stomata and reducing growth regardless of whether it contains contaminants. The effects of dust on vegetation are provided in a list (DEIS Chapter 4.26) but are not provided in context. The effects described in the DEIS include the reduced ability of plants to thrive (burial, reduced photosynthesis, decrease in nutrients, decrease in soil moisture, decrease in moss and lichens), but not how that loss would impact species that use the plants for food (seeds, berries), shelter (nesting, nest materials), pollination, or other purposes. Will the species most at risk be important or common?

> *[Dust can] act indirectly by modifying microenvironment and ecosystem processes, altering canopy structure, soil chemistry, microbial decomposition and soil thaw..... Sphagnum spp. have been considered "keystone" species for controlling tundra ecosystem functions because of their strong effects in acidifying and insulating soils.... We observed a sharp decline in Sphagnum mosses in the most disturbed region of the transect.* (Myers-Smith et al. 2006)

Myers-Smith et al. (2006) observed that evergreens did well where moss and lichens declined. This means dust could exacerbate impacts anticipated with climate change, in which shrub density is increasing across former tundra, wetlands, and glacial outwash areas. These types of landscape scale impacts should be recognized in the DEIS and monitoring methods described.

Vegetation may support insects, and when killed by dust may result in an indirect impact on fish and aquatic life (Eberle and Stanford 2009).

Are any of the plants in the dust deposition zone capable of hyperaccumulating metals? If so, what is the risk posed to insects, birds or small mammals that consume them?

Dust that settles on vegetation of soils is subject to secondary delivery to wetlands, lakes and streams through both windborne and normal rain and snowmelt runoff processes.

Aquatic vegetation

The DEIS states the environmental consequences of fugitive dust on aquatic vegetation as:

> *....the "open water" type is not considered part of the affected environment for vegetation, and impacts to open water would not count as an impact to vegetation. The open water type was not included in calculations in this section* (DEIS Chapter 4.26)

Neither the Vegetation chapter nor the Water-Sediment Quality chapter (DEIS Chapter 4.18) considered the impacts of fugitive dust on aquatic vegetation. Dust entering water bodies could increase turbidity, and decrease water column light penetration, reducing phytoplankton growth (Biggs et al. 1999) and thereby suppressing primary production and inhibiting the foraging efficiency of visually feeding fishes, including salmon, trout, and charr. The measured baseline turbidity of surface waters along the mine access road area was below detection limit (RFI 036). Therefore, reduction in water clarity could substantially affect aquatic ecosystems. One (of many) benefit of clear, shallow waters in northern latitudes is their role in demethylating Hg. If waters in this area do play such a role, increasing turbidity could slow demethylation of globally transported Hg.

There will also be impacts as Cu in dust leaches into waters, or leach onto soils and enter water as runoff. Algae production can decline at Cu increases of only 1-2 parts per billion (ppb; Franklin et al. 2002). Zooplankton and other invertebrates that rely on algae for food suffer decreased growth and reproduction when primary production decreases (Urabe 1991). Zooplankton and lotic macroinvertebrates are also extremely sensitive to Cu increases (Farag et al. 1998, Zipper et al. 2016).

Impacts on fish and wildlife

Fugitive dust may directly impact fish and wildlife habitat by degrading waters (through turbidity), killing vegetation, or causing vegetation to flower early due to dust-driven early snowmelt. The DEIS mentions that dust can cause early snowmelt (DEIS Chapter 4.26), but this isn't followed through with a discussion of the consequences.

Particulate impacts on aquatic life

Particulates from dust alter physical substrate conditions in water bodies. They can accumulate, resulting in transportation of fine sediments that can both directly harm aquatic organisms when they deposit on and abrade benthic plants and animals. Clogging interstices of coarse gravel beds can reduce interstitial and hyporheic flow, degrading the intragravel environment used by benthic insects and smaller benthic fishes such as sculpins that are important in aquatic food webs. Blocked interstices also harm eggs and larvae of substrate-spawning fishes, including all salmonids (Newcombe and Jensen 1996, Henley et al. 2000).

Trace elements

The assessment of fugitive dust impacts completely omitted Cu, which will be the primary trace metal in dust from the mine site, and Zn associated with vehicles. Cu in particular is toxic to aquatic life at very low concentrations. Although Cu is necessary for biological function, it also causes both acute and chronic toxicity to many aquatic organisms. Toxicity increases under acidic conditions, soft waters (low hardness), and in waters low in DOC—all of which occur in waters draining the Pebble deposit (Morris et al. 2019a, 2019b).

Impacts to fish from exposure to Cu occurs primarily through the gills, kidney, olfactory receptors, and lateral line cilia (waterborne exposure), or in the intestine (dietary exposure; Grossell 2011). Olfactory inhibition resulting from Cu exposure occurs within minutes and lasts for weeks or longer, with the potential to affect all aspects of salmonid biology (Grossell 2011). Copper is known to reduce growth, immune response, reproduction, and survival (Eisler 1998). Specific examples of toxic effects include disrupted migration; altered swimming; oxidative damage; impaired respiration; disrupted osmoregulation and pathology of kidneys, liver, gills, and other stem cells; impaired mechanoreception of lateral line canals; impaired function of olfactory organs and brain; and altered behavior, blood chemistry, enzyme activity, corticosteroid metabolism, and gene transcription and expression (Hodson et al. 1979, Knittel 1981, Rougier et al. 1994, Eisler 2000, Craig et al. 2010, Tierney et al. 2010). The effects have been demonstrated for juvenile and adult life stages, primarily of coho and Chinook salmon and rainbow trout. Lethal and sublethal effects of Cu have been shown for salmonids tested with surface water collected from the Pebble site (Morris et al. 2019a, 2019b).

Sublethal effects of Cu are frequently identical to those causing mortality. Physiological effects of Cu exposure include decreased growth, swimming speed or activity, and feeding rates (Waiwood and Beamish 1978a, Waiwood and Beamish 1978b, Marr et al. 1996). Coho salmon exhibit diminished immune response after exposure to Cu (Stevens 1977, Schreck and Lorz 1978). Reproductive performance also decreases in adult salmonid (Jaensson and Olsen 2010). Very slight increases in Cu concentrations (5-25 parts per billion) inhibit olfaction in coho and Chinook salmon and rainbow trout, with potential to inhibit recognition of predators, prey, mates, kin, and natal streams (Hansen et al. 1999a, Hansen et al. 1999b, Sandahl et al. 2007, Baldwin et al. 2011, McIntyre et al. 2012, Morris et al. 2019b).

Chinook salmon and rainbow trout avoid Cu contaminated waters altogether, except after long-term sublethal Cu exposure, after which their avoidance response may be impaired (Hansen et al. 1999, Meyer and Adams 2010). Avoidance can lead to degradation of spawning patterns and resulting genetic diversity which are essential to maintaining overall population structure and sustainability. Adult spawning migrations are delayed or interrupted in Cu contaminated streams, and downstream smolt migration is likewise delayed and osmoregulation of smolts in seawater is impaired (Lorz and McPherson 1976, Schreck and Lorz 1978, Hecht et al. 2007). Cu-exposed salmon are also more vulnerable to predation (Sandahl et al. 2007, McIntyre et al. 2012).

Copper also affects the base of the food chain, interrupting food sources for higher trophic level fish. Numerous studies document indirect, adverse effects of Cu on freshwater algae, zooplankton, mussels, and other invertebrates (Wootton 1990, Scannell 2009), as discussed in the section on "Aquatic Vegetation" in this memo.

Zinc can act synergistically with Cu, magnifying some impacts (Birge and Black 1979).

Additional trace elements may also be present and enter the environment. Selenium is expected to increase in waters near the wastewater discharge plants (Zamzow_2019 04 22_Selenium Position Paper.Final). Selenium is in very low concentrations in surface waters throughout the mine, lake, and road areas (DEIS Appendix K3.18) – should it be entrained in fugitive dust and enter wetlands could quickly become bioavailable. The initial transfer of Se from the water column to sediment is the greatest concentration step, and from there it moves into the food chain (Luoma and Presser 2009). Small concentrations of these elements in dust, transferred then to water and sediment, could result in tissue concentrations that are toxic in fish and birds (Chapman et al. 2009).

Bioaccessibility

Metals in fugitive dust do not need to be in the dissolved form to be potentially toxic. The terms bioavailable and bioaccessible have been used to mean the same or different processes in the literature. For this paper, we define bioaccessible as the extent to which a contaminant is physiologically active and available after having entered the body. This is somewhat different from bioavailable, which we define as the degree to which a contaminant in soil or water can enter the body (or root or leaf). If a metal enters the body but is primarily eliminated, e.g. through the large intestine, it would not be considered to be very bioaccessible.

Knight et al. (2017) tested road dust from Alaskan roads to determine how bioaccessible metals in dust were if dust were ingested or inhaled. Simulated gastric fluid showed Ni and Cu were highly bioaccessible if ingested, with roughly 20%-50% of the concentrations in dust becoming biologically available; between 9% and 22% of Zn, 18% of As, and up to 82% of Pb also became bioaccessible. If inhaled, about 50% of As and Sb became bioaccessible. The variation is likely due to the form of the mineral-sulfides, which were generally less bioaccessible than oxy-hydroxides. However, as noted previously, sulfides are likely to oxidize and release metals when exposed to air. Once ingested or inhaled, Cu is bioaccumulative in many species (Scannell 2009).

Birds and mammals in the dust deposition zone could inhale or ingest dust. These risks should be analyzed in a Revised DEIS.

Connected effects

As discussed explicitly and implicitly in this memo, none of the effects on the environment happen as isolated occurrences. The impacts of fugitive dust – from particulates and from the contaminants leaching from them – occur interactively. Also, they are not isolated from impacts unrelated to dust, such as landscape scale changes, noise, and light.

Multiple toxic sources

There is an assumption in the DEIS that all leachate from the mine will be captured and treated. This is unrealistic. Some leachate from waste rock and tailings will almost certainly occur from the pyritic tailings facility and contribute Cu, As, Se and other trace elements to groundwater (Maest_PebbleDEIS.Comments_20May2019.Final). Because groundwater is highly connected to surface water, trace elements will likely migrate to surface water and compound effects of trace elements leaching from fugitive dust. Additionally, non-acid generating rock will be used for construction, but some – if not separated and isolated – will leach selenium and arsenic, which could reasonably reach surface and groundwater (Maest_PebbleDEIS.Comments_20May2019.Final). Selenium is toxic in small concentrations (Zamzow_2019 04 22_SeleniumPositionPaper.Final). Aquatic life in environments that receive both Se and Cu, or other mixes of toxic metals and metalloids, could be affected in multiple ways.

As mentioned before, birds could be impacted from multiple stressors, including selenium in discharge water, fugitive dust impacts, noise, and light.

Linked physical and chemical impacts

A direct potential consequence of vegetation uncovered by early snowmelt (physical impact) could be that they attract to birds and mammals, exposing them to the heaviest (recently released from snow) loads of metals (chemical impact). Early snowmelt, caused by fugitive dust, is known to attract animals:

> *Perhaps the most profound effect of this early melt corridor is the concentration of waterfowl, ptarmigan, and their predators. In 1986, concentrations of ptarmigan numbering in the thousands occurred, with large flocks commonly sitting on the road and subject to being hit by fast-moving traffic. Caribou take advantage of the early snow-free areas for grazing, and grizzly bears, raptors, and other predators use these areas to hunt ground squirrels and voles.* (Walker and Everett 1987)

These areas of early snowmelt could potentially also harbor high loads of contaminants, accumulated in layers of winter dust. The biological impacts will depend on the contaminant and the receptor, in addition to the biogeochemical processes that make contaminants more or less bioavailable. For example, aquatic life will be affected by Cu while birds will be more affected by Se.

There is no discussion or analysis of these impacts on birds, other than an acknowledgement that the loss of over 9,000 acres of habitat from mine-related disturbance will affect birds (DEIS Chapter 4.23.2.1).

There is no discussion of the biological impacts of exposure to trace elements from fugitive dust through inhalation, direct ingestion, or consumption of tainted prey. Exposure of fish and aquatic life to trace elements from fugitive dust is downplayed, and there is no analysis of exposure, bioaccessibility, or bioaccumulation (DEIS Chapter 4.24). This is a serious omission that must be corrected.

These impacts (loss or change in vegetation, exposure to trace elements, inhalation/ingestion risks) will occur in combination with other known risks, such as noise, light, vehicle collisions, and, for some species of birds, increased threat to nests from ravens (DEIS Chapter 4.23.2) and anticipated risks such as from increased selenium in streams (Zamzow_2019 04 22_Selenium Position Paper.Final).

In aquatic environments, as noted previously, decreased primary production associated with increases in sedimentation and turbidity can produce negative connected effects by way of depleted food availability to zooplankton, insects, freshwater mollusks, and fish. Effects at each trophic level are mortality, reduced physiological function, behavioral avoidance, and decreases in available food; these sublethal effects commonly result in depressed rates of growth, reproduction, and recruitment (Henley et al. 2000).

Connected physical impacts

There is no ecological assessment in the DEIS that discusses impacts from dust diminishing or destroying riparian vegetation, which can affect water temperature, reducing cool areas. What is the pattern expected for dust-fall on riparian vegetation? Are these areas currently pools fish utilize for shade? Are they areas of groundwater input to streams? At what locations will there be multiple impacts such as that of fugitive dust and culverts that become blocked by debris or ice and/or change hydrology, or vegetation impacted by both dewatering and fugitive dust? Are these impacts negligible or significant?

Cumulative effects and the 78-year mine alternative

A better ecologically-focused cumulative effects analysis should be conducted for both the proposed 20-year mine and in the cumulative effects section for a 78-year mine buildout. Currently, the very terse, limited summary of cumulative impacts on wetlands simply assumes that the same ratio of shrub and herbaceous wetlands will be impacted, although the acres of impact from all mine activities would increase from 4,000 to over 21,000 acres (DEIS Chapter 4.22). This was not broken down to show the increase in impacts from fugitive dust, and it is inadequate.

The 78-year mine build out cumulative effects assessment should provide quantitative analysis of the expected concentrations of Cu from combined sources such as uncaptured mine site leachate and fugitive dust leachate. An example of a quantitative analysis of the effects of uncaptured mine site leachate is provided in EPA 2014.

The 78-year mine buildout needs to consider a landscape modified by climate change. This may mean shorter winters – and longer periods when watering may be effective in suppressing dust – but it may also mean longer, dryer summers. How climate relates to dust and dust suppression will need to be overlaid on the broader ecological impacts, which already include earlier bird migrations and may include changes to vegetation and water temperatures. That is, the "No Action" alternative against which the Proposed and other Alternatives are measured will not be the same in the year 2100 as it is in 2020, and cumulative impacts will be additive with other stressors that will be experienced. A reasonable effort to consult with experts should be made, rather than dismissing an apparent rise in temperatures and precipitation from climate change in southwest Alaska.

A Revised DEIS, with greater clarity on expected interacting and cumulative effects, should then provide a monitoring plan to monitor the mine's impacts on ecosystem resources.

Summary and Conclusion

Fugitive dust is recognized as a potential impact of the Pebble mine operations in the DEIS. However, this impact is not treated seriously. The treatment of the potential distribution and associated environmental risks of fugitive dust in the DEIS is inadequate, and as a consequence misleading. It is disjointed, fragmented, seriously incomplete, and relies on outdated and inaccurate assumptions.

The extent and volume of fugitive dust is estimated to be enormous, and distance of dust dispersion is likely underestimated through application of high soil density, low silt content, and ignoring local wind speeds (means and maximums) and topography in DEIS modeling. An estimated 8,300 tons of fugitive dust per year from the mine site are anticipated to impact nearly 1,000 acres of wetlands "and other waters" and 3,000 acres of vegetation, annually for a minimum of 20 years. The Revised DEIS should provide an independent third party review of the mine site dust plume model inputs. This should lead to an updated estimate of the increased concentration of metals deposited via fugitive dust from the mine site.

We have provided evidence that Cu will be a primary component of dust, and a dominant toxic metal leaching from dust; Zn is also likely to be a component, and other trace elements may be present in more limited concentrations but biologically important. A Revised DEIS must analyze the environmental consequences of fugitive dust settling on vegetation, wetlands, and waterways, and the potential impacts of decades of Cu, Zn, and other trace elements leaching into the environment.

The Revised DEIS needs to assess the impacts of fugitive dust and trace metal leaching on aquatic life. Fugitive dust on thousands of acres of vegetation and hundreds of acres of wetlands and water bodies will be exposed to different pH and redox environments. This was not considered at all in the assessment of ecological impacts in the DEIS. Without geochemistry, the risks from fugitive dust cannot be assessed. A conservative estimate could consider the entire mass of trace elements as bioavailable to show the high end of possible impact.

Additionally, the environmental effects of dust abatement measures themselves, including sourcing, transport and spread of large quantities of water, and potential chemical palliatives, are entirely ignored in the DEIS. This is discussed in depth in Frissell_16May2019_Fugitive dust_road system.Draftv3.

Finally, a cumulative impacts analysis should be written to understand the potential biological impacts of dust deposition. Because the mine is very likely to expand from a 20-year mine to a 78-year mine, the cumulative effects of the quantity of dust on vegetation, wetlands, and water bodies needs to be assessed, the cumulative effects of increased concentration of metals in the dust as they leach out into underlying vegetation, wetlands, and water bodies needs to be assessed, and the increasing physical effects (e.g. early snowmelt, increased soil temperatures) as they link to biogeochemical cycling and biological impacts needs to be assessed. The impact of 8,300 tons of mine site fugitive dust over the landscape annually may not follow a linear pattern, but have multiplier effects, and will occur on a changing landscape.

The DEIS severely underestimates the ecotoxic immediate and cumulative effects of fugitive dust on fish and aquatic life. It needs to remedy this deficiency.

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Re: Pebble FEIS on discharge of selenium

Introduction

In April 2019, a technical team of 6 authors submitted a joint comment paper as comments on the Pebble draft Environmental Impact Statement (DEIS) regarding the risks to birds, fish, and wood frogs from likely discharge of high concentrations of selenium from the water treatment plant, and related increase in water temperature at the discharge location. This general paper was followed by specific and detailed comments from Ann Maest (re pit lake concentrations of selenium likely to be higher than the DEIS anticipates), from Andre Sobolewski (on the likely inability of the water treatment plant to reduce selenium to safe or legal levels), from Gordon Reeves (on likely impact of warm water at discharge site), and from Chris Frissell and Sarah O'Neal (on bioaccumulation). As the lead author of the memo, I provide here a high-level overview of key failings of the FEIS in responding to concerns.

DEIS Issue: Inadequacies of Water Treatment Plants (WTPs)

This topic includes the issues of discharge of high selenium (with impacts to local fish, frogs, and birds), discharge of warm water (with impacts to fish), and pit lake water quality. There is reason to believe that selenium concentrations entering the Pebble WTP will be higher than modeled, that the plant itself will not be able to treat the very high volumes of water expected, and as a result high selenium will be discharged in wastewater, with effects locally on aquatic life, including fish, frogs, and birds.

FEIS response

1. Each of these concerns was dismissed with the statement that "All water that is discharged from the wastewater treatment plants will be required to meet Alaska water quality criteria." (FEIS Appendix D)
2. The water treatment process design will continue as the project advances. Potential mitigation options include detailed water balance modeling and pilot plant testing, among others (FEIS 4.18.4.1). If the treatment is ineffective, modifications would be required (FEIS K4.18.2.5).
3. Proof of concept for the treatment plan was not required; it could be provided during APDES permitting (State of Alaska wastewater discharge permit).

Comment

The FEIS now includes statements of misgivings about the ability of the WTP to treat water (FEIS Appendix K4.18.2.5) – but does not require any action from PLP.

> *"...at a conceptual stage of development, there is limited ability to identify significant technical failures of the treatment strategies."*
>
> *"It should be disclosed that the approaches have not been demonstrated at the scale of the Pebble mine, and the specific configurations .... have not been commercially demonstrated."*
>
> *"....the mechanism for removal of various constituents requires different operational conditions for pH and ORP .....The information [on WTP design] does not specifically define the operating conditions of the WTPs, which creates uncertainty as to the effectiveness of the overall solutions"*
>
> *"The removal efficiencies are quite high relative to performance observed in other operating mine treatment systems in the world.....the information [on ability to remove contaminants] appears to be optimistic. This is particularly true for selenium....."*

EIS cooperating agencies did request additional information from PLP, SRK, and Knight-Piesold between November 2011 and March 2020. The main points to take away:

1. **Proprietary models allowed.**
    a. **Proprietary models were applied, such that it is difficult for independent reviewers to repeat the work.**
    Specifically, the MetSim mill process model was used to inform the GoldSim model to determine whether salts would build up on the WTP equipment, causing it to be less efficient or fail (RFI 021h).

    b. **Co-reliance of four different consultants could lead to "finger-pointing"**
    To determine whether the wastewater discharged would meet water quality, PLP relied on four consulting firms. SRK did geochemistry testing on ore and other rock "to inform water treatment technologies". HDR dealt with what goes on inside the water treatment plant while Knight-Piesold dealt with what goes on outside the water treatment plant (site water balance, water quality at different locations around the mine). Lorax specifically looked at water quality in the pit lake over time.

The problem is that if all of the methods and models applied by all four are not transparent or in the public domain, there is no way that regulators or independent consultants can verify the work by any one group. We also do not know if any group is re-running methods by any other group, or just relying on the inputs they are given. For example, Knight-Piesold relies on SRK's geochemistry and HDR's model of character of the brine waste that leaves the water treatment plant to go to the pyrite tailings facility as inputs in their site-wide water balance and water quality.

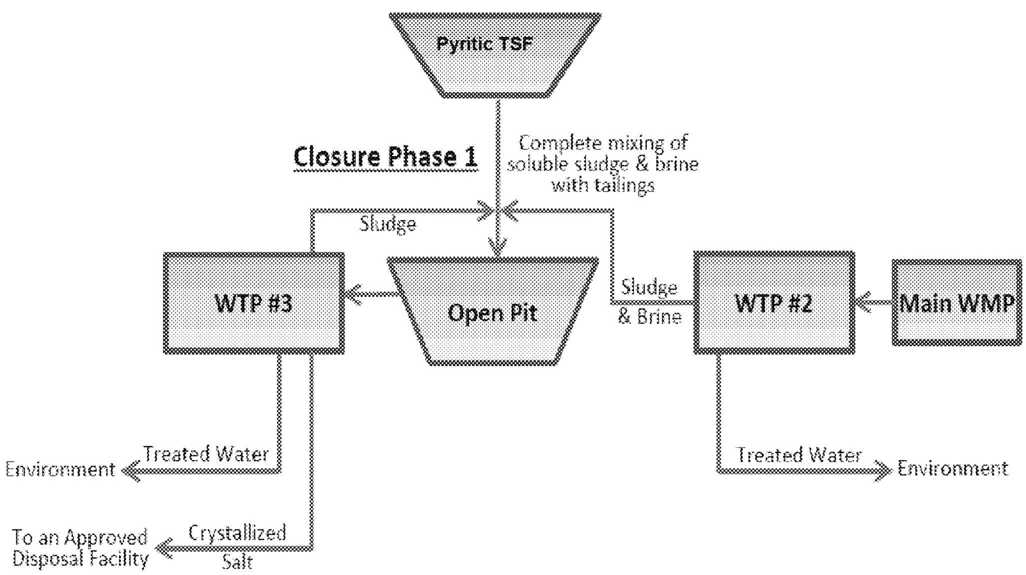
The inability to redundantly confirm results is dangerous, and combined with the use of four different firms means that it is possible no one will become the responsible party if results are wrong.

2. No repercussions for false or misleading information.

In response to our DEIS comments, the FEIS authors requested information of the concentration of constituents at each part of the treatment process in the WTP so they could follow where each was being removed. They also requested information on maintenance procedures, consumables, and how water temperature would be lowered before discharge. They were told the information would be provided at the APDES permitting stage.

a. **The expected reliance of the DEC APDES wastewater permit on the FEIS creates a permitting failure point.** PLP's response was that they wouldn't know any of this until pilot plant testing, which would be done for the APDES permit. However, in our experience, the APDES permit relies heavily on the FEIS. The authors of the PFEIS could insist that pilot plant work be completed before the FEIS is written, but they have not taken that step.

b. **New waste products.** As a result of some Tech Team comments, HDR and Knight-Piesold re-ran models and determined that if salt were to build up in the WTP, it would occur at WTP #2 in the first closure phase (RFI 021e Appendix B and C and RFI 021i). Yet one of the primary changes was the addition of plans for a "brine evaporation/ crystallization" system to WTP #3 "if needed" (RFI 021e) due to salts re-mobilized when pyrite tails are moved to the pit, which would not affect WTP #2, and this is why the brine evaporation step was added, which will crystallized salt – an estimated 6,000 lbs per year of which would then need to go to "a facility for disposal" (RFI 021h, see image). There are no details on where this material will be disposed.



3. **Regulatory failure to apply oversight**
   There is no mine in the world that is currently attempting to treat volumes of water as high as Pebble will expect. This is not made clear in the FEIS. Instead, the caveats shown above in italics were given.

We would expect a mine with an ore deposit of this size, which mining companies have actively explored for over 15 years, which expects water treatment to require significant technological and financial input, would have a pilot WTP. Where mining companies failed to set up a pilot plant, regulators could have stepped in. Instead of vague language, a pilot plant should have been ***required*** before the FEIS was allowed to be completed. This would have provided better information on salt buildup and plant efficiency, and details of disposal locations for waste products, such as salt, would have been included in a FEIS. While there may be issues with modeling by individual consultants, the failure to require a pilot plant is a failure at the regulator level.

DEIS Issue: Pit lake water quality

DEIS Criticism: Acidic water in the pit lake
The Pebble DEIS predicts neutral to alkaline (pH ~ 8) water in the pit lake. Maest and Wobus counter that this is highly unlikely with the acid – generating material of the deposit. An acidic pit lake could result in bird deaths, as is seen at the Berkeley Pit in Montana.

FEIS response
In responding to concerns about birds, the USACE responds (FEIS pD-15) that they updated FEIS Section 4.23 to show the differences between the Berkeley Pit and Pebble pit lake; however, this language continues to predict neutral pH in the Pebble pit lake, and does not explain why neutral pH will occur in a deposit of acid-generating rock.

Comment:
This goes back to the issue of whether models can be re-created by independent consultants. Information from all four of the consultants, as well as by a fifth (BGC) working on groundwater and dewatering, is important to determining pit lake water quality. In updated models, based on SRK, HDR, and Lorax inputs, Knight-Piesold specifically provides a footnote that they did not model the pH (RFI 021e Appendix B and C). The FEIS does replace a non-public modeling code for groundwater hydrology (used by Piteau Associates) with a public USGS code (used by BGC) – they could require public codes be used for water quality modeling as well.

Summary/Conclusions

We continue to expect that selenium will be discharge in high concentrations from the water treatment plant – at concentrations greater than state water quality criteria and high enough to have ecotoxic effects locally. I have provided these as a birds-eye view and example of the way that the process is broken. Although EIS authors attempted to obtain information to answer our questions, they stopped short of obtaining relevant answers. Instead of working through substantial issues – which would require investments of time and money, but which would provide more reliable information on the most critical and longest-standing component of the mine facility – issues were kicked down the road with vague assurances.

Regards,

Kendra Zamzow

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